POWER PLANT ENGINEERING

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For High-Tension Transmission Service

NEW DIXON STATION OF ILLINOIS NORTHERN UTILITIES CO. UTILIZES MODERN COAL HANDLING EQUIPMENT; NOVEL ARRANGEMENT OF INTAKE PREVENTS DIRTY SCREENS

IN THE MANAGEMENT of public utility properties, as well as that of the isolated power plant, economy of operation is today of more vital importance than heretofore, and in order to insure the lowest possible unit cost, financial considerations frequently warrant the replacement of otherwise satisfactory installations with plants embodying equipment of the latest development. Ultimately the savings realized by such changes will many times offset the first cost of such new plants, and especially so in the face of the ever rising cost of labor, fuel and other items involved in the generation of power. Even during the period of our participation in the great conflict overseas, when government requirements were enormous, it was found advisable, in the case of all essential industries, to make such changes as would guarantee the conservation of man-power and our natural resources.

Amongst the most recently constructed central power stations is that of a subsidiary of the Middle West Utilities Co., the Illinois Northern Utilities Co., located at Dixon, Ill. This station, which was placed in operation June, 1918, is now the largest steam plant operated by that company, and in conjunction with a number of smaller hydro-electric developments, feeds a high-tension transmission system forming a network covering practically the entire northwest section of the state of Illinois.

FIG. 1. TURBINE ROOM OF NEW DIXON POWER HOUSE

The power-house proper is a structure of steel, con-

crete and brick, having overall dimensions of approximately 90 by 100 ft., and except for a basement, but a single story in height.

Located as it is along the south bank of the Rock River, an abundant supply of water for both boiler feed and condensing purposes is available at all times, although to guard against shut-down, due to a possible shortage, provision has been made whereby water may be taken from the city mains. A 2-in. service line has been provided for that purpose.

Main Water-Supply System

Figure 5 illustrates in plan, sectional elevation and detail, the arrangement and construction of the intake and discharge cribs, tunnels and the wells which are located in the basement of the turbine room, and to which the various pumps are connected. The intake crib, a wooden structure of the form shown in section, Fig. 5, is protected by rip-rap arranged in the manner indicated, and in order to prevent the entrance of leaves, sticks, trash and so forth into the tunnels and wells, has been equipped with two sets of removable screens. These,

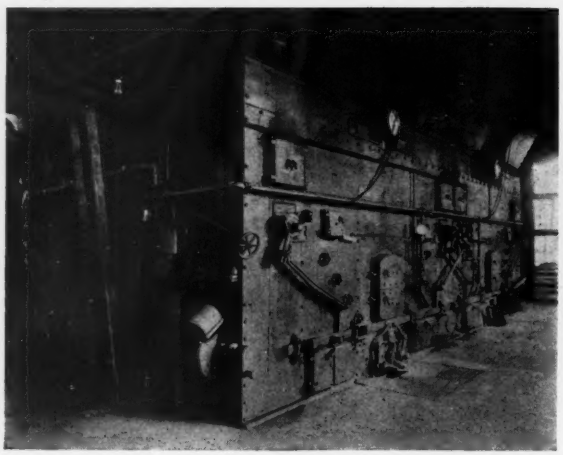


FIG. 2. FIRING AISLE OF DIXON STATION

which are each built up of wooden framework having overall dimensions of 8 by 8 ft. and are fitted with ½-in. mesh heavy wire netting, have been placed at an angle of approximately 60 deg. with the horizontal. Removal for cleaning is accomplished by means of a hand-operated differential tackle suspended from above.

Intake and discharge wells each having a depth of 26 ft. and sections 8 by 5½ ft. are connected to the river by reinforced concrete tunnels, cast integral to a point within about 15 ft. of the intake crib; from here the discharge tunnel, which is carried above the intake, branches off at an angle of 45 deg., thus emptying into the river some distance down stream. With this arrangement the possibility of the discharge finding its way into the intake tunnel is entirely eliminated. Walls and bottom of the tunnels are 8 in. thick, and for the greater part are reinforced with American Steel & Wire Co.'s No. 38 wire mesh reinforcing.

Boiler feed makeup and water used for general house purposes is taken from the intake well through an 8-in. suction line connecting with two service pumps, each a 200-gal.-per-minute Worthington centrifugal unit, one direct connected to and driven by a Westinghouse 12-hp. steam turbine and the other to a 15-hp. induction motor. These pumps, through the medium of a 5-in. line and a riser of the same size fitted at its upper end as shown in the accompanying illustration, with a float valve, discharge into a 2500-gal. house service tank located on the roof of the building, or if conditions so require, into an 8-ft. concrete hot water reservoir, the line supplying this being likewise equipped with a float valve. The hot water reservoir may, therefore, be supplied either by the pumps or, when they are not in operation, by the tank.

A 3-in. Yeomans Bros. vertical centrifugal pump placed within the reservoir and driven by a 5-hp. electric motor located on the boiler room floor delivers the makeup through a 3-in. line to a 6 by 14-ft. Platt Iron Works open type horizontal heater.

Directly below this, as shown in Fig. 3, are the boiler feed pumps, two 150-gal.-per-minute Worthington centrifugal units each direct connected to a 50-hp. Westinghouse steam turbine. The line used to connect the pumps and heater also serves as a discharge for the hot water

FIG. 3. BOILER FEED PUMPS

pump, thus providing two sources of supply to the boiler feed pumps, the discharges of which terminate in a common 4-in. header fitted with 2½-in. branches for each boiler and a 4-in. by 8-ft. air chamber.

Steam Generation and Distribution

Although provision has been made for four units of that size, there are at present installed but two 500-hp. Stirling water-tube boilers. These, which are constructed of extra heavy steel throughout, are equipped with B. & W. superheaters and 12 by 7-ft. Murphy stokers capable of being operated either by a steam engine or electric motor.

Under ordinary conditions of operation, steam is generated at a pressure of 200 lb. gage, although before being utilized it is superheated approximately 150 deg. F. Gooseneck connections as shown in the accompanying illustrations deliver the steam to the superheaters from where it is further conducted by 6-in. leads, each fitted with an automatic stop and check valve of like size to a loop header made up of 8-in. and 2½-in. sections, the former for main unit service, while the 2½-in. line

is primarily used to supply the auxiliaries. With the scheme of connections and valving layout employed, either section may be temporarily cut out of service for repair or otherwise without material interference with the operation of the station.

Fuel and Ashes Handling

Coal is the fuel used and is delivered to the station in cars over a siding jointly used by the I. C. and the C. N. W. railroads. A wide gage electric locomotive crane built and furnished by the Orton & Steinbrenner

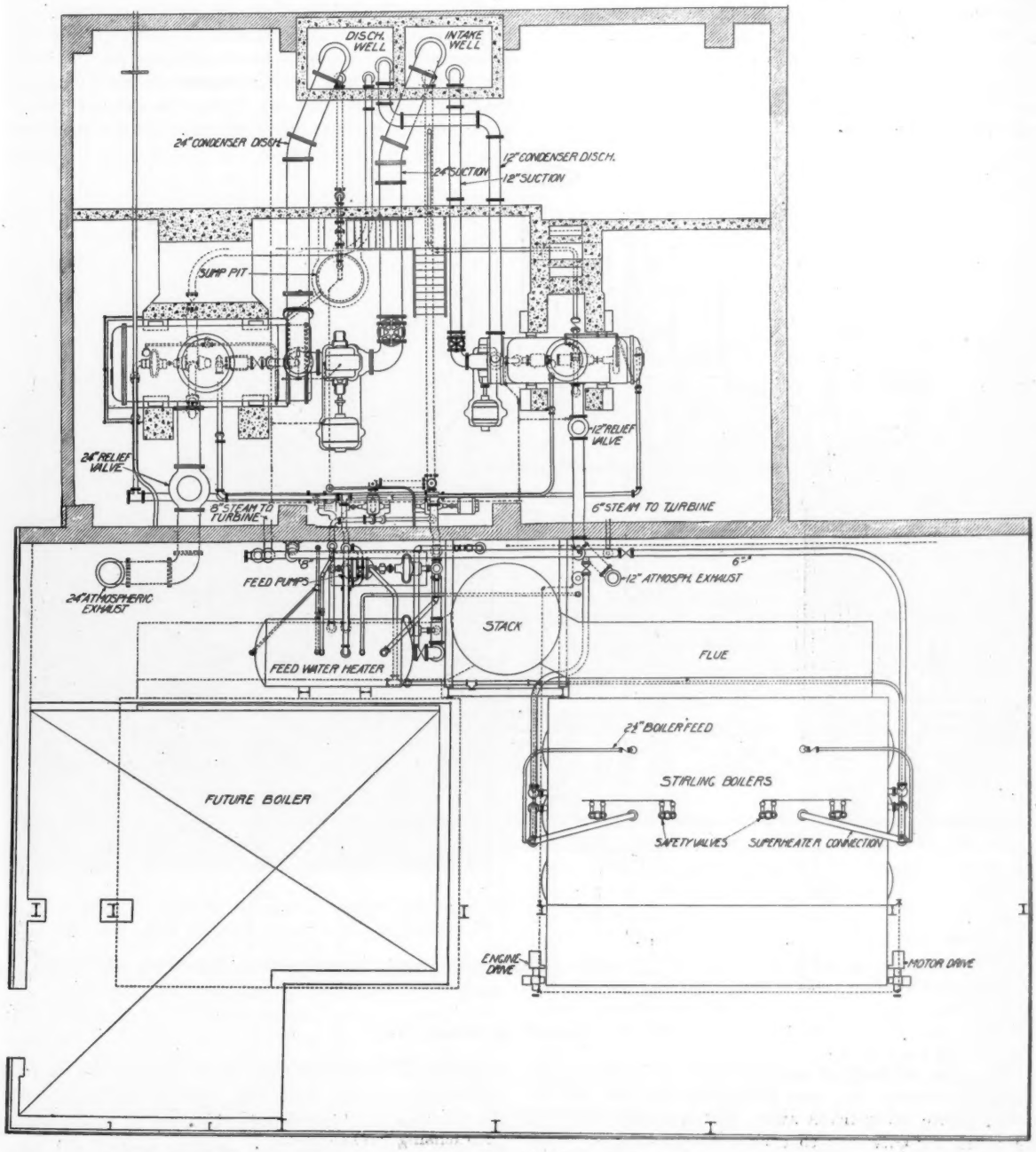


FIG. 6. PLAN OF DIXON PLANT

The branches serving the prime movers are carried through the wall separating the boiler and turbine rooms. That for the 3750-kv.a. set has a diameter of 8 in., while the 750-kv.a. unit is supplied through the medium of a 5-in. branch.

Co. and equipped with a 50-ft. boom and a 1½-cu. yd. clam shell bucket transfers the coal from the cars to a four-roll crusher. This, which is operated by a 25-hp. electric motor, has a capacity of 50 tons an hour in lumps up to 18 in. and crushes the coal to such fineness as will

allow the passage of 90 per cent through a ¾-in. ring, and the remainder through a 1-in. ring.

Upon being discharged by the crusher, the coal is received by the buckets of an elevating conveyor capable of raising 50 tons each hour and driven by a 10-hp. motor, which delivers it to a 120,000-lb. Fairbanks-Morse steel weigh hopper placed near the roof of the boiler room. From here, after being weighed, it is carried to the stokers by means of a drag conveyor.

For the greater part, the ashes are manually handled. After being raked from the pits below the stokers into small cars, they are dumped into a receiving pit and periodically removed by the locomotive crane.

750 kv.a.; each of these units delivers current at a voltage of 2300 and a frequency of 60 cycles per second.

Excitation in the case of the larger unit is obtained from a direct connected exciter, while that for the 750-kv.a. set is supplied by a 10-kw. General Electric motor generator set.

In the basement of the turbine room are located the condensers. These are of the Westinghouse Co.'s surface type equipped with separate circulating and condensate and air pumps, the circulating pumps being driven by individual electric motors, direct connected, and the condensate and air pumps by steam turbines. The condenser serving the larger unit has a capacity of

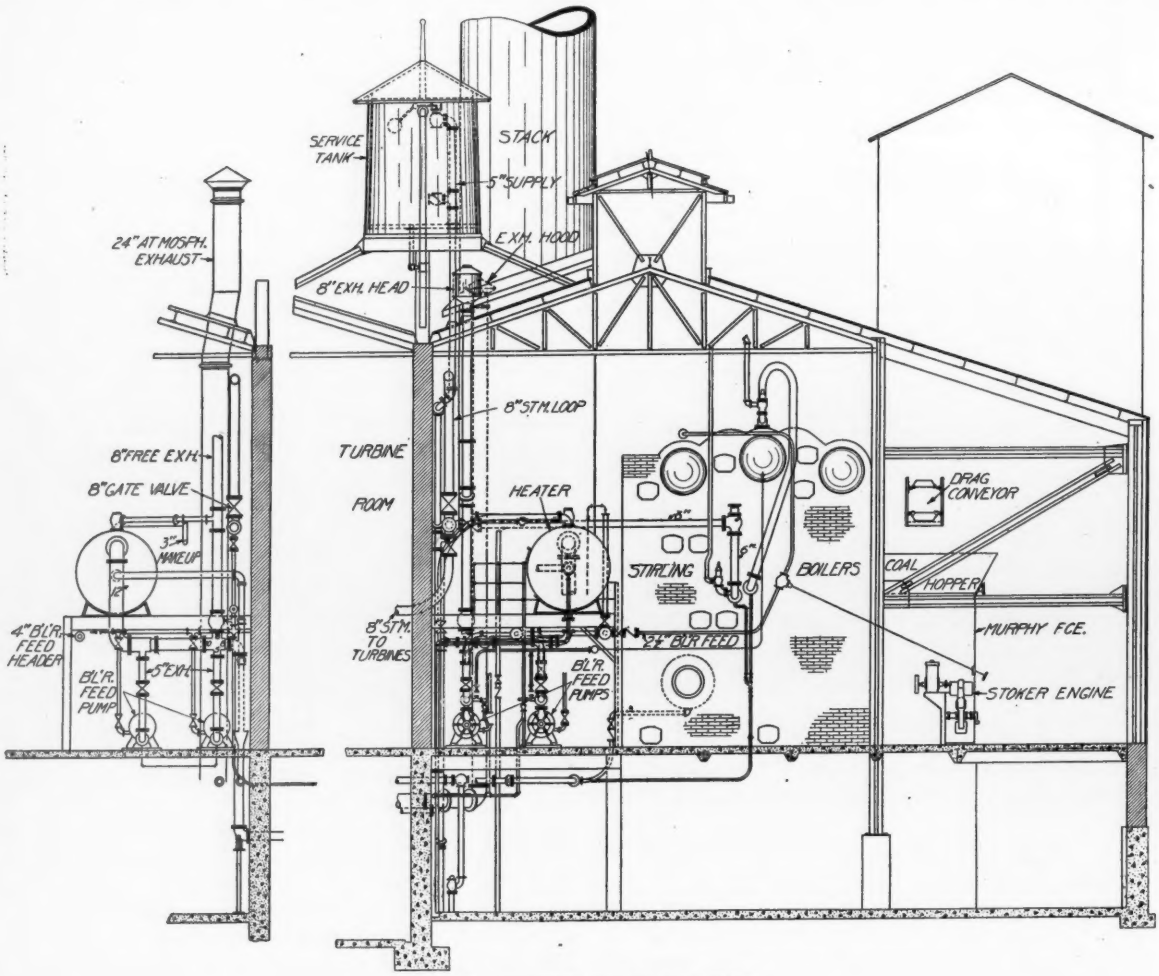


FIG. 7. SECTION OF BOILER ROOM

As all the ashes are at present being purchased by the railroad company, the cars delivering the coal are reloaded before being taken away, thus not only enabling the operating company to realize considerable revenue from this source, but also facilitating their ready disposal.

Prime Movers and Auxiliaries

As shown in the accompanying illustrations, the turbine room at present houses two main generating units, one a turbine set of General Electric make rated at 3750 kv.a., and another of like make, but having a capacity of 45,000 lb. of steam per hour and contains 7500 sq. ft. of condensing surface, while that used in conjunction with the 750-kv.a. machine contains 2000 sq. ft. of condensing surface. An 8000-gal. per minute centrifugal pump direct connected and driven by a 100-hp. electric motor operating at a speed of 700 r.p.m. supplies cooling water to the large condenser; the smaller one capable of condensing 12,500 lb. of steam per hour to a 28.5-in. vacuum with 70 deg. F. cooling water is served by a 2200-gal.-per-minute centrifugal pump operated by a 40-hp. motor, the speed of which is 1750 r.p.m. This unit takes water

from the intake well through a 12-in. line and discharges into the discharge well through a line of like size.

Twenty-four inch lines arranged as shown in Fig. 6 serve the 7500-sq. ft. condenser.

Each of the condensate pumps discharges into a 5-in. main which connects directly with a Platt Iron Works horizontal open-type heater located in the boiler room, from where, after being mixed with the makeup taken from the hot water reservoir, the water is delivered to the boilers as required by means of the centrifugal feed pumps provided for the purpose.

The main auxiliary exhaust line made up of 3 and 6-in. sections is carried along the boiler room wall, and by means of an 8-in. tie line passing through this wall

FIG. 4. EXTERIOR VIEW OF STATION SHOWING LOCOMOTIVE CRANE AND HIGH-TENSION SERVICE TRANSFORMERS

into the boiler room, where it connects with the main 12-in. exhaust header leading to the heater. A bypass fitted with an 8-in. combination back-pressure and relief valve and continued to the roof of the boiler room in the form of a free atmospheric exhaust allows the cutting out of the heater for cleaning or repair. The heater exhaust is fitted with a 4-in. back-pressure valve.

Electric Control and Distribution

In Fig. 1 is shown a general view of the main switch and control board. Of the 11 black slate panels of which this board consists, one serves a 33,000-v. tie line, two the main generating units, one the house motors and voltage regulators, two the exciters, two the house motor controls, two the emergency lighting and switch operating battery and one the 2300-v. commercial circuits and the local tie line connecting with the Dixon hydro-station.

A 60-cell storage battery furnished by the Electric Storage Battery Co. and having a capacity of 80 amp. for 1 hr. and a momentary rating of 400 amp., furnishes energy for the operation of the switching equipment and the emergency lighting system.

For the system service, three 1200-kv.a. oil-cooled transformers have been installed outside of the station,

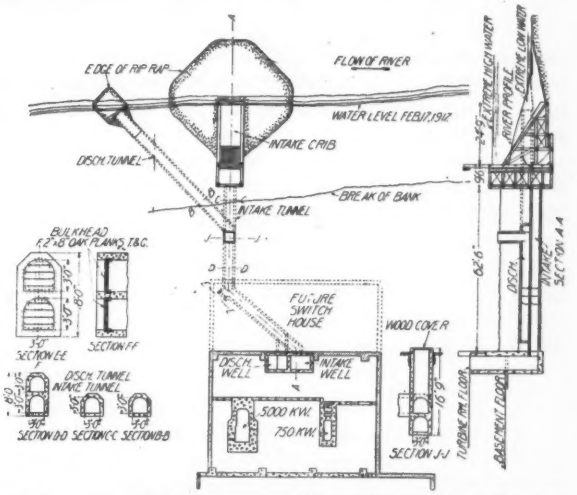


FIG. 5. ARRANGEMENT AND CONSTRUCTION OF CRIBS AND TUNNELS

as shown at the right of Fig. 4. These transformers receive current at 2300 v., and step up to 13,000 v. to correspond to that carried on the high lines.

This station has been in operation since May, 1917, enabling the company to meet, in a most gratifying manner, the abnormal fuel and labor conditions and new demands for power so universally encountered during the last 6 mo. of the war period.

Secretary of the Treasury Carter Glass has officially announced from Washington that the name of the next (fifth) war loan will be the "Victory Liberty Loan."

Originally it had been planned to call the next issue the "Fifth Liberty Loan, Victory Issue," but Secretary Glass, after giving the matter due consideration, finally brought forth the happy combination:

"Victory Liberty Loan."

So "Victory Liberty Loan" it is, and it is believed that every worker will be inspired with renewed zeal to back it up to a victorious finish, and every consistent American patriot with the determination either to start saving or continue to save in order to acquire "Victory Liberty" bonds when they are offered next spring, and thus contribute to two patriotic ends, viz.:

(1) Bring the victors home.

(2) Finish the job.

The honor flag of the "Victory Liberty Loan" will bear a blue "V" on a white field, surrounded by a red border, the "V" denoting both "five" (fifth loan) and "victory."

It is stated that at Staaken, the big German airplane works are constructing a machine with 198 ft. wing spread and 3000 hp. of engines for a trans-Atlantic flight.

Improving Factory Steam Plants---VI

CASE IV. PUTTING OLD PLANT IN CONDITION TO FINISH ITS YEARS OF SERVICE EFFICIENTLY. BY H. A. WILCOX

IN THE preceding three cases, it will be remembered that I had at least a few instruments to work with when I started my investigations. This case differs radically from the others in that I had no instruments of any kind until the work was almost completed. It is therefore written for the purpose of showing what can be done today in the ordinary steam plant by means of applying a little common sense and then spending money in the right direction.

The plant was not very large and was engaged in the manufacture of plushes, mohairs, etc. There were practically three departments in the mill which used all the power produced and these were the finishing, weaving, and dyeing. The first two were fairly constant loads, while the dyeing was a varying load and was intermittent. Part of the power was transmitted through line shafting and part was through electric motors. The plant made its own electricity and had no connection with the central station in any way.

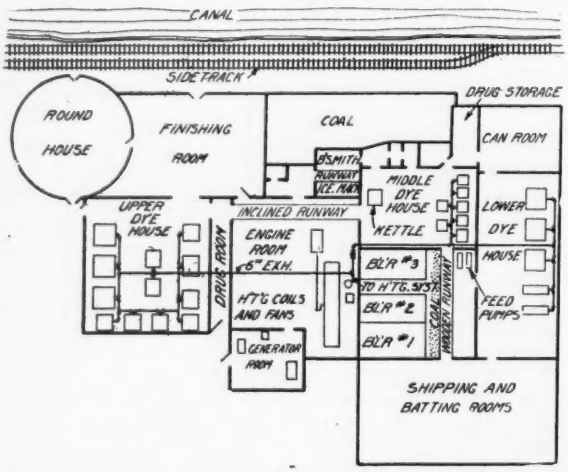


FIG. 1. GENERAL PLAN OF INDUSTRIAL PLANT CONSIDERED

It hardly seems necessary or desirable to attempt to give the details of the equipment of the plant in this article, as the method of attacking the problem rather than the results attained is the most important thing. Therefore just a general idea and a rough sketch showing the relation between the various components has been given.

The boiler equipment consisted of three horizontal return tubular boilers having a capacity of about 150 hp. each. Each boiler had its own stack and damper. Numbers one and two were also controlled by a damper regulator which operated the dampers in their stacks in unison. Number three had its own damper regulator. There were plain water columns on all the boilers and hand regulated feed was obtained through a duplex pump located in the boiler room. This pump had no governor and a duplicate pump was held in reserve. Water could be drawn from the canal (see Fig. 1) or from the city water mains. The boilers were fired by hand and stationary grates were in use. Natural draft was employed with the use of steam jet blowers as an auxiliary when needed. The fuel was number one buckwheat. The amount of feed water used was not measured in any way, but an attempt to keep track of the coal burned was made by counting the number of wheelbarrows used per shift and assuming that each one weighed 300 lb., a practice which, by the way, I have found to be in use in almost every plant I have investigated. A simple illustration will serve to show the value of this method very plainly.

If any of my readers were to go to a store to buy potatoes, would they feel satisfied to have the storekeeper take an ordinary burlap bag of potatoes and say that it held 100 lb., as he had filled it to the same point that he was accustomed and had found that it generally weighed somewhere near 100 lb. that way? I don't think that either the storekeeper or the customer would stand for it. However, that is the way that a great many plants are run today and managers quote their coal consumption figures as being quite accurate. If the wheelbarrow has to be pushed quite a distance, the natural tendency of the coal-wheeler is to slight the load and so show up more coal than was actually used, or by overloading, fool the management into thinking less coal is used than is the case. Somebody may say that this discrepancy will be shown up in the coal bills for the year; but, owing to the manner in which coal is generally stored in these plants, it is difficult to obtain any accurate estimate of the amount of coal on hand at inventory time and so the bills do not show up the error until a long time has elapsed. To return to our subject: The boilers were all tied in together, but not in a header, and supplied steam at 110 lb. pressure to the engine, etc.

The engine was a simple Brown engine and was installed about 25 yr. ago. By means of a belt around the flywheel, the main line shaft of the mill was driven and through a counter shaft a 150-kw. alternating current generator was driven, which supplied current for driving the motors throughout the mill. A 75-kw. direct-current generator was also driven from this same countershaft and supplied the lights. A small twin cylinder slide valve engine was located in the basement of one of the buildings and drove a 90-ft. tenter frame. This engine could be thrown onto a 15-kw. direct-current machine which supplied the lights on week ends and whenever the main engine was shut down. The main engine was good for about 300 hp. and was run non-condensing, exhausting to atmosphere. A small amount of the exhaust steam was bypassed to a closed heater and a small amount to an open heater, both of which heated the feed water. By this means, a temperature of 100 deg. F. was obtained for the water entering the boilers. These were the main elements of the power situation when I first came to the mill.

There were two main reasons for investigating this power plant: First, the old trouble of low steam pressure. Nearly every morning it was necessary to shut the engine down and consequently the whole mill for from anywhere from one-half to one hour on account of

the fact that the steam pressure was only 75 lb. and the engine would not run up to speed. Although the steam blowers were turned on in an effort to get the pressure back before stopping the engine, they seldom did any good and the engine was generally stopped and the fires cleaned before the pressure could be brought back to the proper point.

Second, the management wished to make an earnest effort along the lines of fuel economy and conservation as a patriotic duty.

I requested the purchase of an Orsat, recording steam gage, draft gage, and feed water meter and while waiting for this apparatus, made a careful study of the running conditions as they were.

Having made this brief study and having made friends with the fireman and engineer on the job, I made the following brief report. I neglected to state that this plant ran only 54 hr. per week; that is, a day shift only.

The Steam Situation

Analysis

The inability of the boilers to maintain the requisite steam pressure in this plant at all times seems to be due to several factors.

1. Non-use of all the exhaust steam from the engines, pumps, etc.
2. Dirty boilers.
3. Low feed water temperature.
4. Lack of system in the fire-room.
5. Bare steam and hot water piping.
6. Antiquated apparatus and lack of necessary equipment.

Discussion:

1. Exhaust steam. Quantities of exhaust steam constantly escape through the exhaust head. This steam should be used in process work if possible and for heating the feed water to a higher temperature and none of it should be allowed to go to waste.

2. Dirty boilers. The boilers are opened up and cleaned out generally every two weeks. There is some scale, but the amount is diminishing, due to the treatment of the feed water with a good boiler compound. The tubes are blown and brushed once a week and the combustion chambers are cleaned at boiler inspection time or oftener if they get filled up.

3. Feed water. Feed water has been entering the boilers at about 100 deg. despite the fact that plenty of exhaust steam is going to waste and the fact that the two heaters are easily capable of raising the temperature of this water to 230 deg., as I have demonstrated to my own satisfaction. The reason for keeping the temperature down is given by the fireman and is that if the temperature gets up much above 100 deg. the feed pump will not handle the water.

4. There is no system whatever in the fire-room and no records of any kind are available other than an approximate estimate of coal burned. This item needs no further explanation. Furthermore, my study of the routine in the boiler room has developed the following facts, as far as I can determine them without the use of instruments: Engine shut-downs, due to low steam pressure, almost invariably occur between the hours of nine and twelve in the morning. The heaviest and most variable steam load in the plant, the dye-house, is generally pulling its hardest during these hours. It has been the custom for the past 25 yr. to clean the fires under boilers one and two during the above hours. These items will be considered again later in this report.

5. Non-insulated piping. There are very few steam and hot water pipes in the plant which are insulated in any way. A large amount of heat is thus lost through radiation.

6. Equipment. This item will be considered under "Recommendations" in this report.

Recommendations:

1. Exhaust steam. The large amount of exhaust steam now wasted to atmosphere can and should be utilized for three purposes:

A. Heating in winter.
B. Boiling in the kettles in the dye-house.
C. Raising the temperature of the feed water.

If there is any amount of steam left after filling the above requirements, it could be used to produce heat for the coils on the tenter frame. This would involve considerable expense, due to the fact that the heating coils would have to be rebuilt and cut down into a number of sections in order to enable the steam to be used successfully. On this account, I have not recommended that this change be made at present, but would prefer to wait and see if we will have a surplus of exhaust after taking care of items A, B and C.

A. This item is already taken care of and I understand that exhaust steam has been used for heating purposes for several years. Provision has been made for admitting live steam to the heating mains in case of a deficiency of exhaust and for heat when the engine is stopped. I might suggest that a reducing valve, set to open at 5 lb., be placed on the live main connecting to the exhaust line. Then when the pressure in the heating mains drops below 5 lb., the reducing valve will automatically open and maintain the proper pressure. At present, the engineer has to watch the pressure and open up on the live steam whenever the pressure gets too low. This is bad practice, as he might let the pressure get too high and then atmospheric relief valve would open and allow live steam to escape to the atmosphere.

B. We have already arranged to use exhaust steam in three of the largest kettles in the dye-house and are waiting for the O. K. of the boss dyer before putting it into eight more kettles. We are running a back pressure of 6 lb. on the engine and this will not affect its operation in any way except to increase its water rate, which is a good thing, as we believe that the supply of exhaust steam will be insufficient when we have arranged to use it in all the kettles, etc. We have therefore installed a reducing valve on the exhaust mains. This valve will automatically admit live steam, reduced from boiler pressure to about 4 lb. whenever the pressure in the exhaust mains to the kettles falls below 5 lb. The atmospheric relief valve on the exhaust line is set to open at about 6 lb. The construction of the exhaust piping for supplying steam to the kettles has been and will continue to be quite expensive, but the use of the exhaust for this purpose will make ample return on the investment both from the standpoint of economy (the utilization of heat now thrown away) and for obtaining a more uniform pull on the boilers at all times. The heavy expense is caused by the necessity for using large size pipes for conveying the low pressure steam.

At this point I would like to digress a little and tell about a little conference at which I was present the other day, as it has a direct bearing on the subject which I am now discussing. This paragraph did not appear as a part of my report. An advisory engineer for the fuel administration of a county in Massachusetts, the manager of three Massachusetts plants, and an efficiency engineer were discussing the use or rather lack of use of exhaust steam in industrial plants all over the country. The advisory engineer advanced the theory that the name "exhaust" was responsible for its non-use, as its name implied something of no use or discarded. He therefore thought that a change of name to "low pressure steam" would help some. The manager took the stand that in most plants it had been customary to throw away exhaust for years and that the personnel of the plants have a fixed idea, which is extremely hard to overcome, that the old-timers would have used exhaust if it had been possible to do so and that therefore it could not be used at all. The efficiency engineer seemed to think that the non-use of exhaust steam at present is due to the fact that most piping systems used to carry it are improperly designed. In other words, the use of exhaust requires larger mains, fewer bends, and shorter runs than would be the case if live or high pressure steam were used. I am inclined to agree with the last theory, having found from a number of instances, in different plants, complaints were made that the reducing valves for admitting live steam to the exhaust mains did not work right or were too small. Upon examining such installations, I have often found a 1-in. reducing valve connected by a long line of 1-in. pipe to the exhaust main which was also obviously altogether too small for the work required of it. Moving the reducing valve right up close so that the low side discharged directly into the exhaust main and enlarging the main overcame the troubles. I think that a few opinions from my readers on this subject would prove of value at this time. Anyone may easily satisfy himself as to the heat value of exhaust steam by referring to any steam table and comparing the difference in the total heat in steam at 5 lb. pressure with that of steam at, say, 125 lb. pressure. In the first case, it is 1155.9 and in the second 1192.2. This alone speaks for itself.

C. It has been roughly estimated that for each 10 deg. of increase of the temperature of the feed water entering the boilers, 1 per cent of the fuel burned is saved. By using a larger amount of exhaust steam in the heaters, previously mentioned, we have raised the temperature of the feed water from 100 deg. to 210 deg. Theoretically this means an 11 per cent saving in the coal burned, but we cannot prove this as we have no accurate records of previous coal consumption for comparison. This change has made itself felt, however, in the increased steaming capacity of the boilers. The feed pump works properly at this temperature, but will not handle water at a much higher temperature unless it is first overhauled and put in proper condition. It seems to be worth while to do this, as we could then get a feed water temperature of about 225 deg.

2. In order to do good work, the boilers must be kept clean at all times. To do this properly, under present labor conditions, the installation of mechanical soot blowers will be necessary. It will cost a total of about $325 to install these blowers on the battery of boilers. I have ascertained that about $100 per year is paid in overtime to the fireman for blowing the tubes under the present system and they are blown only once a week at that. The adoption of mechanical soot blowers would save the above amount and the tubes could be blown at any time during regular working hours and the work would be done more thoroughly. In addition, there would be a material saving in fuel on account of the heating surfaces being kept clean at all times. The objection may be advanced that the boilers are quite old and will have to be replaced shortly and the blowers thrown away. To meet this objection, I may state that the blowers could be removed and adapted to new boilers at slight expense, provided the new boilers are of the same type as the old, namely, horizontal tubular. The installation of other types of boilers would involve the erection of a new boiler house and in that case the blowers could be sold at a little less than their first cost if they are kept in good condition.

I would recommend that each boiler be washed out, scale chipped off, and its combustion chamber cleaned out at least once in two weeks. Up to the present time, I have not had time to secure much data on scale conditions in the boilers, but I understand that the boiler inspector has recommended the use of city water as feed water in preference to canal water. There is apparently very little scale on the heating surfaces and I believe that the use of city water for feeding should be continued.

3. Low feed water temperature. This has already been discussed at length elsewhere.

4. Lack of system in the fire-room. This constitutes a most perplexing problem at the present time on account of labor conditions. It will therefore be approached gradually and I do not advise any attempt to introduce a rigid firing system into the boiler room for some time to come. An attempt will be made to install a little system by starting daily reports or logs, ticklers, and a schedule for the maintenance and operation of the power department, after sufficient information has been collected to enable me to do this.

5. Non-insulated piping. There is a very large amount of piping throughout the whole mill which should be insulated or covered in the proper way. The covering of all steam and hot water piping has been let out by contract and is proceeding rapidly. This work will cost about $7000 when finished. In the long run, this job will pay for itself, by saving in fuel. Furthermore, work of this nature is recommended and almost insisted upon by the United States Fuel Administration. This covering will be painted with one coat of white lead and the brass strips which hold the covering in place will be painted black, which gives it a pleasing appearance.

6. Equipment. I hesitate to recommend the purchase of a large amount of expensive accessories and equipment for this plant on account of the fact that in all probability an entirely new power plant is a natural development in a few years, as most of the equipment has already been in use for about the length of its natural life and due to the fact that the growth of the mill is outstripping the capacity of its power plant and material additions to the present capacity of the power department are somewhat limited on account of lack of

available space. I do feel, however, that a few things would prove of value and would pay for themselves in actual savings within a very short time. These items I have enumerated below.

a. For "Safety First" reasons, high and low water alarm columns should be installed on all the boilers. The blowoffs from the columns should be piped to the ash pits. Incidentally, may I remark that this recommendation was accepted and that when we put the columns up we found that the 1½-in. feed connections to the boilers had a clear passageway of about ½ in. in diameter at some points? As a consequence, we had to replace practically all of the feed piping, using extra heavy iron on account of the high present cost of brass. In doing this we also changed the connections to the closed heater so that the water and exhaust steam flowed in opposite directions instead of in the same direction as formerly. (Let some of my readers who are having trouble in feeding their boilers, examine the feed piping. They may find similar conditions to account for their trouble, instead of a poor boiler feed pump as they had previously supposed.)

b. Install feed water regulators on all the boilers and a governor which will take care of both the regular and the spare feed pumps. This should insure a uniform feed at a uniform temperature at all times. This helps to prolong the life of the boilers. The regulators which I have in mind also have the following advantage: When the load is light, they automatically carry high water in all the boilers and so afford a storage capacity to pull from when the heavy load appears. When the load is heavy, they feed slowly and do not kill the steam on heavy pulls.

c. Install a feed water meter so that the economy of the plant may be checked up at any time and a running record of the evaporation and other items of interest be obtained every day on the logs.

d. Buy and use draft gages and find out by test the best draft to carry with due regard for efficiency and then check the draft up from time to time and see that this is being lived up to.

e. Buy and use at least twice every day or oftener if possible an orsat for the purpose of checking up the work of the fireman. Encourage him when he is doing good work and help him when things go wrong. A little attention in this way will soon pay for the effort in fuel saved.

f. Overhaul the present damper regulators and get them working properly. This will assist in maintaining a uniform steam pressure and a minimum expenditure of fuel.

g. Install a recording steam gage on the main from the boilers in order to keep tab on the fireman and to be able to prove to the insurance company, in case of fire, that you have been carrying at least enough pressure to operate the fire pump at all times in accordance with their requirements. You may be the next one to suffer from fire and you would not wish to lose your insurance because of this simple thing.

h. Install water relief valves on the engine cylinder. I have already noticed several times that a dose of water is drawn over into the engine cylinder when the water is quite high in the boilers or the steam pressure is down to about 75 lb. and the engine running with hardly any expansion. It is at this point that most of the shut-downs have occurred in the past. These valves cost very little and they may save a cracked cylinder head some time with its consequent shutting down of the entire plant while a somewhat long repair is being made. No plant which depends upon one engine for all of its power can afford to take chances of this sort.

i. Pick up and pipe back to the open heater all hot drips except those from the trap discharges from the oil separators. Some of this work has already been done and the job should be completed.

j. Use exhaust steam in all of the dye kettles. Continue the use of exhaust steam in the skein drying cans; for heating the buildings in winter and for heating the feed water. Install a 2-in. reducing valve set to reduce from boiler pressure to 5 lb. and connect the low side by a close nipple to the large exhaust main running across the engine room.

All of the above changes and equipment, except for the pipe covering and running exhaust mains to the dye kettles, would not cost over $1000 and would pay for themselves within one year in the saving in fuel and labor and the increased production, due to the absence of shut-downs for various causes.

The above report was submitted to the manager of the plant and was discussed in detail with him. In the end, all of my recommendations, except for the installation of mechanical soot blowers, were adopted. The cost of putting in the large piping necessary for conveying exhaust steam to the dye kettles was so prohibitive that this work proceeded very slowly, the upper dye house being completed first. This showed such good results that the middle and finally the lower dye houses were put on exhaust steam also.

A great improvement was made when we hired a fireman who had fired on the Government tests in St. Louis. This man could appreciate the ends we were trying to attain and entered heartily into all of our plans and our final success was in no small measure due to his efforts.

(To be continued)

"A Man's a Man for a' That"

Do you think of your Italian acquaintance as a "Dago?" Marconi is of the same race. Do you refer to your Polish neighbor as a "Polak?" Paderewski is a Pole. Are your Scandinavian fellow-workers "squareheads" in your mind? The inventor of dynamite and the armored battleship were men of that stock. And this argument applies to every race that has found a home in America. It is wrong thinking to use slurring names, even in your mind, about the men of another race. Think straight, and judge a man by his character, not by his birthplace.

German workshops have used a paper substitute for driving belts. The paper is cut into narrow strips, spun and then woven or braided. In the "fabric" belt, the fabric is cut into bands 40 in. long, then joined up according to the required width and thickness, a core of strengthening material, cotton, sheet metal or paper thread and wires interwoven, being interposed. Over this core the paper strips are placed, and the whole sewn with strong thread. The tensile strength of these belts is said to be from 90 to 110 lb. per inch of width.

Pulverized Coal in an Industrial Plant

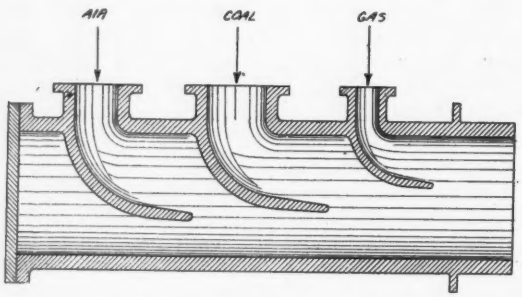
Its Preparation and Method of Application at the Plant of the Mansfield Sheet and Tin Plate Co.

By C. A. Dille

THE large brick building in which was installed the machinery for crushing and pulverizing of the coal was placed as near centrally as possible between the north and the south plants.

The initial operation consists of dumping the coal from the car into a 10 by 10-ft. track hopper from which it is fed by means of a single reciprocating plate feeder into the hopper of a 24 by 24-in. two-roll Webster coal crusher. Thence the coal is fed into the 18-in. belt conveyor which delivers it into the 12-in. screw conveyor which serves to distribute the coal uniformly along the concrete storage at the side of the pulverizing building. The 18-in. magnetic separator which is suspended above the belt conveyor removes from the coal all iron which would make trouble if it got into the pulverizers.

The second operation is the removal of the coal from the concrete storage bunker by means of any or all of the three 9-in. screw conveyors driven by variable speed motors, so as to secure the correct adjustment in the feed through the different stages of this unit to the pulverizers. The coal is delivered from the three 9-in. screw



SPECIAL BURNER FOR PULVERIZED COAL OR GAS

conveyors onto the 18-in. belt conveyor which feeds the bucket elevator. From this the coal is elevated and passed through a Richardson automatic scale where an accurate weight record is automatically registered. It then passes into the 9-in. screw conveyor which feeds the 4 by 30-ft. rotary coal dryer. The dryer delivers the coal into a 9-in. screw conveyor which conveys the coal to a one ton bin feeding the two 18-in. 1¼-tons-per-hour pulverizers.

The 9-in. screw conveyor dryer is also provided with a discharge spout and a sheet steel receiving box intended to furnish a supply of coal for firing the furnace of the dryer. The quantity of coal fed to the pulverizers can be regulated by turning by hand the screw which adjusts the throw transmitted from the crank shaft to the pusher feeder. The fine particles of coal are extracted from the pulverizing chamber by means of a partial vacuum within the sheet steel separator chamber created by the suction of the 45-in. mill exhausters. These fans deliver the mixture of coal and air under pressure to the 6-ft. 8-in. diameter collectors which discharge into the 6-in. bypass screw conveyor from where the coal can be delivered from either collector to either of the 25-ton pulverized coal bins simply by operating the bypass conveyor in the desired direction. Reversal is secured by means of a double throw switch in the line to the driving motor.

The fineness of the coal should be 95 per cent through a 100 mesh screen.

It has been found that it is necessary to secure the fineness of 95 per cent through a 100 mesh screen. A disk must be placed in the pipes discharging from the exhausters to the collectors. The size of the opening which is required in these disks will have to be determined by experiment. To suit conditions we are using 10 in. diameter. These disks can be inserted between connecting flanges on the pipes.

In commencing the operation of unit No. 2 the motors are started in this order: First, 6-in. bypass screw conveyor run by a 3-hp. 840-r.p.m. motor. Second, two 45-in. exhausters run by a 7½-hp. 840-r.p.m. motor. Third, two 25-hp. 850-r.p.m. motors driving two 18-in. pulverizers. Fourth, 9-in. screw conveyor from dryer to one ton bin run by a 3-hp. 840-r.p.m. motor. Fifth, 7½-hp. 840-r.p.m. motor driving 4 by 30-ft. coal dryer. Sixth, 5-hp. 740-r.p.m. motor driving the bucket elevator, 18-in. belt conveyor and 9-in. screw conveyor into dryer and automatic scale. The 18-in. belt conveyor did not prove satisfactory so has been taken out and a 10-in. screw conveyor replaced it. Seventh, 4½-hp. 580 to 1740-r.p.m. motor driving the three 9-in. screw conveyors out of the coal storage pit. The operation in stopping unit No. 2 is just the reverse of that in which they are started.

The third unit consists of feeding the pulverized coal by means of the 6-in. feed screws from the two 25-ton pulverized coal bins to the respective 41 by 10⅞-in., 6000-cu. ft.-per-min. distributing blowers. Two 41 by 7¾-in., 3600-cu. ft. booster blowers serve merely to maintain sufficient pressure to keep the pulverized coal in suspension throughout the distributing systems and back to the 5 ft. 4 in. diameter return line collectors. These booster blowers are located about midway or at the farthest point in the line from the pulverizing plant somewhat near 1000 ft. and between the sheet and pair and the annealing furnaces.

We have two small air compressors run by a belt direct from booster shaft furnishing air for the special stuffing box in booster blowers at both the south and north plants. The north plant is located about the same distance from the pulverizing plant as the south is. It was necessary to tunnel under the railroad track and then elevate about 40 ft. to attain again the right height to pipe to the furnaces.

The quantity of compressed air need not exceed 2 cu. ft. per min. per booster at a pressure of 2 lb. per sq. in. We use, however, about 6 lb. and it is very important that this air be used to insure satisfactory operation of the booster blowers; we tried it without and burned the boxing. It is quite essential that a uniform mixture of air and coal be maintained at all times within the distributing systems. This is secured by the variable speed at which the screws are driven, the speed of which is

controlled by the air regulator and its connections to the air indicator; thus making the amount of coal fed into the system proportional to the quantity of air delivered by the blowers. A float rests on stops of the air indicator and the needle set to indicate 2000 cu. ft. of air per min. on the dial.

This quantity of air flows through the distributing system when no furnaces are being served. With the indicator registering 2000 cu. ft. of air per minute, the two 6-in. feed screws should be running at their minimum speed, 10 r.p.m. As valves along the line are opened, the indicator float will rise and is so attached to a pilot motor in the regulator, controlling the position of the arm of the rheostat that it will in turn speed up the motor driving the feed screws to maintain the right mixture of coal and air. This mixture will not give complete combustion and it is necessary to add sufficient secondary air at the burners.

We had quite a little trouble with the coal clogging in the pipes leading to furnaces, so attached a pipe from secondary air line near main coal line direct into controlling valve and have had but little trouble since. We use a special burner furnished by the Bonnet Co., a sketch of which is shown herewith.

The controlling valves to burners are controlled by a hand wheel at front of ovens or furnaces, which were or are being made by men employed at the coal plant and machine shop. At present we have 10 sheet and 10 pair furnaces, also 10 annealing furnaces. The longer we use the coal the less trouble we have with it. Of course one has to learn to use different fuels; one which is new to nearly all, is pulverized coal. As air is to gas so is it to pulverized coal. If the proper amount of air is supplied very little if any smoke is visible. Since starting this writing there have been installed 2 more pulverizers and a 1-ton bin fed by the same 9-in. screw conveyor. The order in which the motors for either of the distributing units should be started is as follows: First, a 25-hp., 1730-r.p.m. motor driving the booster blower. Second, a 35-hp. 1730-r.p.m. motor driving the distributing blower. Third, 2¾-hp., 535 to 1600-r.p.m. motor driving 6-in. feed screws. The order in stopping the motors is just the reverse of starting.

The Coal Saving Problem

FREQUENTLY OVERLOOKED FACTORS WHICH ENTER INTO THE SOLUTION. BY F. G. WORKER*

CONDITIONS in boiler plants show that operators must be trained in the combustion of fuel. Specialization is as much needed for the highest efficiency in coal burning as in any other work. Building up the standard of intelligence in the boiler room involves no disparagement of this kind of work. Opportunities should be offered for an intelligent understanding of the principles involved in order to acquire and maintain a high standard of fuel burning. The following paragraphs point to losses frequently ignored, every one of which deserves careful investigation by those in charge of operation.

Emission of black smoke from stacks is a sure indication of waste. Prohibiting this smoke will result in proper firing methods, which will reduce the waste of fuel. The demand should be to stop hand-firing of boiler furnaces and other furnaces where capacity is beyond the reserve capacity of the equipment.

Without the aid of recording or indicating instruments, it is not feasible to apply measures of economy. While an experienced fireman can approximate the conditions of a fire by looking into the furnace, it is impossible for the average man to do so. The following instruments should be installed and backed up by intelligent supervision and a definite plan of records: Draft gage, indicating the draft in the furnace above the fuel bed; generally a gage indicating 1½-in. water column pressure; also a draft gage indicating the draft at boiler side of the flue damper, generally a gage indicating 2-in. water column pressure; steam flow meter for individual boilers, the indicating type of meter being preferable, due to simplicity.

Additional instruments, such as recording flow meters, recording pyrometers, etc., may be of advantage dependent upon plant organization, size of plant, and operating conditions in general.

The principal product of complete combustion of coal is CO_2. The percentage in flue gases is a guide as to how efficiently coal is being burned.

A common source of loss is high percentage of carbon in the ash. Extreme care should be exercised with hand-fired and stoker-fired furnaces to reduce the carbon in the ash to a minimum.

Exhaust steam wasted means coal wasted. Use exhaust steam whenever possible. If very much is being wasted, there may be something wrong and it would be advisable to obtain engineering assistance.

In hand firing and many forms of mechanical stoker, faulty operation is due to air spaces in the grates being clogged. A systematic method should be used to overcome this difficulty by keeping the air spaces clean.

Baffles are installed for the purpose of deflecting the gases over the entire heating surface of the boiler. They should be inspected at intervals, as leaking or broken baffles will allow the gases to short-circuit to the stack, resulting in high flue gas temperature and consequent loss in coal.

Scale formation, be it on the inside or outside of a boiler tube, will decrease the heat transfer to the water contained in the boiler, and a large percentage of the coal will be lost, due to the fact that the flue gases will leave the boiler at an excessive temperature. The proper cleaning of tubes, therefore, becomes of paramount importance, especially where impure feed water has to be used and the boilers are operated at relatively high ratings.

Boilers should be cleaned internally at predetermined intervals; generally, frequent turbining of the three rows of tubes nearest the fire is sufficient, with a thorough cleaning of the entire boiler, at longer intervals.

Boiler tubes should be blown externally once every 8 hr. when boilers are in continuous service. Many satisfactory makes of soot blowers are on the market for this purpose.

With certain kinds of coal, the lower rows of tubes are liable to be coated with a clinker formation due to fusing of fine ash which is carried with the gases at relatively high gas velocities. This formation must, in

* Westinghouse Electric & Mfg. Co.

most instances, be removed by scraping of the tubes; blowing with steam at frequent intervals will reduce the time interval between scraping periods. It is important that this point receives attention, otherwise the formation mentioned will obstruct the gas passageway through the tubes, impairing furnace draft and preventing relatively high boiler ratings.

Smoke flues should be made as short and direct as possible; all turns should be avoided, and whenever found necessary they should be of the largest radius permissible, because they offer great resistance to the passage of the gases and cut down the draft appreciably.

Flues should be made air tight and all joints and connections well fitted, calked and riveted to prevent air leakage. Too much attention can hardly be paid to this point, since many small leakages distributed over the area of a long flue greatly impair the draft.

A common source of air leakage is the improper fitting of clean-out doors. Asbestos gaskets should be used, and it is advisable to pack the joint between frames and doors with asbestos wool each time the doors have been used.

The control of the flue dampers for each individual boiler should be located at the front of the boiler setting so that quick and easy adjustment can be made for variation in loads. Damper operating mechanism poorly arranged or located in the rear of the boiler setting is very seldom adjusted by the firemen.

The size of coal has a considerable bearing on the relative capacities and efficiencies obtainable from a boiler. The air pressure penetrates the fuel bed formed by the coarse coal more easily than the fuel bed formed by the finer coal, resulting in disturbance of the best furnace conditions.

Gas Fired Boilers

By Mark Meredith

IT may usually be taken for granted that where power is to be generated from gas fuel it is more advantageous to install an internal combustion engine; but many cases arise in which, for considerations overriding that of thermal efficiency, it is desirable to burn the gas under boilers serving a steam engine, and in such cases it is important that the boilers should be well adapted to the special requirements of gaseous fuel combustion.

There is a disadvantage in the Lancashire boiler when gas-fired in any of the usual ways in that the fall of temperature in the gases from one end of the flues to the other is not sufficient to set up good circulation of the water as is done by the intense local heat of the fire when the boiler is coal-fired. Boilers of the Lancashire type intended for gas firing would be better with three or four flues, instead of the usual two, as that would not only give a larger heating surface, but also allow of smaller volumes of gas being burned in each flue, which would enable combustion to proceed with a smaller excess of air.

Carrying this line of argument a little further and keeping in mind the advantages of the flue boiler over the water-tube boiler when using feed water of doubtful quality, the best results would probably be obtained by having a boiler with a considerable number of smaller tubes, forcing the gas to burn at the highest possible temperature in each, with no obstruction in the tubes and no mechanical suction. Such a boiler, properly insulated, would give at least as good results as the best water-tube boiler, provided that the correct ratio of boiler length to flue diameter was ascertained.

This could be worked out at a comparatively small cost by experimenting on pipes of different diameter and length immersed in a water tank. Wherever high-pressure boilers are to be installed there is little doubt that water-tube boilers will be chosen if the available feed water is soft enough, or can be suitably treated. It is important that sufficient combustion space should be provided for the huge volume of gas to be burned, so that the gas may be fully burned before passing through the tubes, but external combustion chambers should be avoided as causing unnecessary losses by radiation and combustion of heat and because the highest temperature is not attained in the immediate vicinity of the tubes.

The two great drawbacks to the gas-firing of boilers as against their firing with coal are the low rate of evaporation per square foot of heating surface, which with the best water-tube boilers is seldom more than 5½ to 6 lb. of steam per hour, and the relatively low efficiency obtainable. The best boiler up to the present is unquestionably a water-tube boiler which is arranged so that the gas can be fully burned before passing through the tubes, and where the gas stream is kept at right angles to the line of the tubes by careful baffling, and to get higher outputs from such a boiler per square foot of heating surface only requires a more rapid combustion of the gas, with more intense flame temperature.

Because of the low rate of evaporation and low efficiency of gas boilers, the project of gasifying steam coal, recovering the by-products and burning the gas under steam boilers has not made much headway, as it has been found that steam can be raised more cheaply from the coal direct, even after allowing for all the income derived from the sale of by-products. Even now there are modern producer plants and boilers on the market which can make gasification and gas-firing a commercial success under suitable conditions, and improvements are to be looked for.

Back Up Our Victorious Boys

By Otto H. Kahn

THEY made good over there—officers and men alike. They made good everywhere, from Cantigny to Sedan. They made good on land, on the seas and in the air; worthy comrades of the war-seasoned heroes of France and Great Britain, worthy defenders of American honor, eager artisans of American glory.

I have had the privilege of seeing these splendid boys of ours, in all situations and circumstances, from their camps in America to the front in France—the boys and their equally splendid leaders.

I confess I find it hard to speak of them without a catch in my throat and moisture in my eyes. I see them before me now in the fair land of France—brave, strong, ardent; keen and quick-witted; kindly and clean and modest and wholly free from boasting; good-humored and good-natured; willingly submissive to unaccustomed discipline; uncomplainingly enduring all manner of

hardships and discomforts; utterly contemptuous of danger, daring to a fault, holding life cheap for the honor and glory of America. What true American can think of them or picture them without having his heart overflow with grateful and affectionate pride?

A French officer who commanded a body of French troops, fighting fiercely and almost hopelessly in Belleau Wood near Chateau-Thierry (since then officially designated by the French Government as the Wood of the Marine Brigade), told me that when they had arrived almost at the point of total exhaustion, suddenly the Americans appeared rushing to the rescue. One of the American officers hurried up to him, saluted and said in execrably pronounced French just six words "Vous —fatigues, vous—partir, notre job." "You—tired, you —get away, our job."

And right nobly did they do their job. Need I ask whether we shall do ours?

Heaven forbid that we should permit an impression to go out to our soldiers that we took good care of them as long as we needed them to stand between us and the enemy, but that when the danger to us is past, we fail them. The debt of gratitude which we owe to them cannot be measured or discharged in money, but we can at least prove to them that we love them with proud and tender affection and that their well-being is a first charge upon our means.

America has broken many a record since we entered the war. There is one record yet to be broken before our boys come home. That is the record of the outpouring of a naton's gratitude to its defenders.

We have proved that America is not the "land of the almighty dollar," as too many believed and as especially our enemies fatuously believed to their undoing, but a land of high idealism, ardently zealous to do and dare and spend itself in a righteous cause.

A new and exalted spirit pervates the land. We have made a new pact of unity. We have come to understand and appreciate each other better. We respect each other more. We are justly proud of the qualities which all Americans have proved themselves to possess in common.

The Fifth Liberty Loan to care for our victorious army will need our full support. Let us prepare for it now.

America comes out of the war with her economic and moral potency and prestige vastly enhanced, with her outlook broadened, her field of activity expanded, her enterprise quickened, her imagination stirred, her every faculty stimulated.

The vista which opens before us of America's future is one of dazzling greatness, spiritually and materially. The realization of that vision cannot fail us if we but meet our problems in a spirit of true Americanism, of moderation and self-restraint and of justice and good will to all, respecting alike privilege and demagogy, banishing all class rule, be it of capital or of labor.

In that spirit let us grasp each other by the hand and thus resolved and united against enemies without or foes within, let us march on towards the high destiny that Providence has allotted to the country which in grateful pride and deep affection we call our own.

GET THE HABIT of doing things right. This will mean: Greater production, less waste, increased earnings. Work for good times all the time.

Railway Rates or Taxes

SOME facts given in the Railway Age bring out a startling and serious condition in the affairs of our great transportation systems. In a recent editorial it is shown that the late director-general of railways, before a Senate committee, stated that with present freight and passenger rates, a surplus of $100,000,000 could be earned in 1919 above the return guaranteed to the companies.

Figures show that from August to November, 1918, the increase in earnings was $457,000,000 and the increase in expenses $465,000,000, as compared with the corresponding months of 1917, or a decrease in net earnings of $8,000,000 for the 4 mo. Further, the operating income, which is net earnings less taxes and uncollectable revenue showed a marked decline. For August it was $128,000,000; for September, $101,400,000; for October, $89,500,000; for November, $57,000,000. As the guaranteed return to the companies is $80,000,000 a month, November showed a deficit of $23,000,000 after this guaranty was taken care of.

Decline of both freight and passenger traffic has been rapid since the Armistice was signed, and all wage increases granted in 1918 have not yet begun to show in expenses. It seems likely, therefore, that the deficit will increase rather than otherwise, and the only way to avoid it is either to reduce expenses or increase income. Nobody believes that wages will be reduced. In fact, they are still being increased. Efficiency of labor in many branches has declined seriously, and it seems doubtful whether it can be increased under government operation.

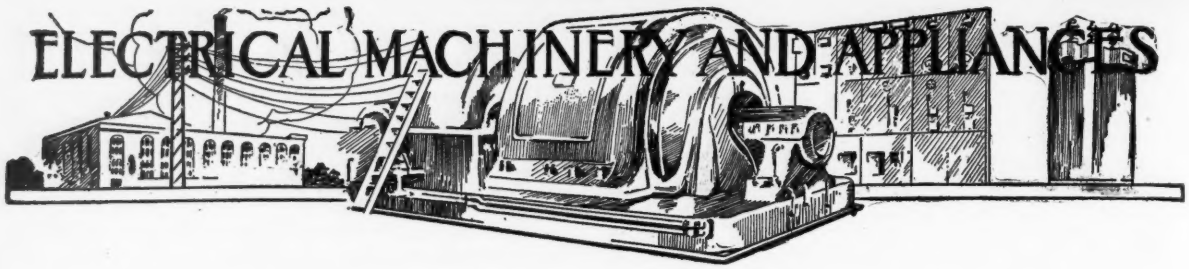
There are left the alternatives of advancing rates considerably or of increasing the taxes paid by the public at large to the extent of some $250,000,000, to meet the deficit for 1919.

To return the railroads to private operation with present conditions of income and expenses, and no government guarantee of net income, would be to invite ruin of many companies and a probable panic.

Increase of rates after return to private operation may take a long time, judging from what has happened in the past, and might not be available in time to avert disaster, yet it seems that return to private operation is necessary if economies in operation are to be effected.

The situation is full of problems and dangers, and no reliance on the estimates of the former director-general of railways should lull us into a false sense of fancied security.

A NEW driving belt leather substitute is now being manufactured in Austria. This article, which is called driving-belt leather substitute or iron leather (according to an announcement of the Treasury to the Customs), is made of double iron wire spirals twisted together and in part slightly copper-plated by a chemical process. One sample is about 10 cm. broad. Another sample is of wire gauze strips interlaced with one-ply and two-ply paper yarn, partly with single and partly with double threads. It is bound at the edge with paper yarn, then strongly impregnated with tar asphalt and flattened out between rollers. A third sample is bound with iron wire spirally twisted.



Characteristics of Electric Motors---II

ALTERNATING-CURRENT MOTORS

MOTORS operated by alternating current may be of the synchronous, the single or polyphase induction, or the commutating type. Synchronous motors require not only some outside source as a small engine or other smaller motor (except those few provided with windings allowing starting by induction motor action) to start and bring them up to speed, but at all times operate as their name implies, at synchronous speed. Machines of this type are, therefore, only adaptable for service requiring little starting torque and constant speed. Another disadvantage of this type of motor is its inability to carry any considerable overload without falling out of synchronism or "step," as it is commonly termed.

Primarily, synchronous motors are employed for

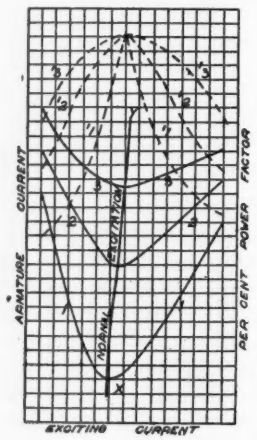


FIG. 6. CHARACTERISTIC OR V CURVES OF A TYPICAL SYNCHRONOUS MOTOR

power factor correction purposes, although, if so desired, they may to some extent be utilized for the operation of machines.

In addition to their inability to correct power factor, synchronous motors may also be employed to balance polyphase circuits. Over-exciting the field of such a motor tends to cause it to draw a leading line current, the degree of lead being dependent upon the degree of over-excitation of the field.

An unbalanced phase, due to greater load, will naturally experience a greater drop in voltage, so that a synchronous motor connected to the ends of a transmission system will, under conditions of unbalance, be supplied with current through one phase at a somewhat lower voltage than through the other phases. With the fields over-excited, the armature winding connected to the low-voltage phase will, due to its relatively greater degree of over-excitation, draw a heavier leading current from the line than the other phase or phases, thus tending to create a condition of balance.

To understand more clearly this characteristic of the synchronous motor, attention should be given to

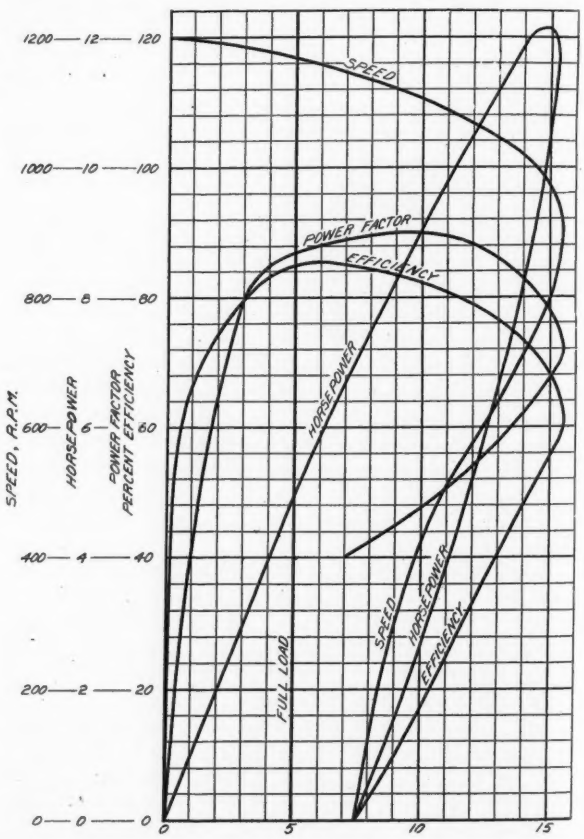


FIG. 7. CHARACTERISTICS OF A 5-HP. 3-PHASE INDUCTION MOTOR

the phase characteristic or V curves shown in Fig. 6. From this it will be noted that, if the exciting current is reduced or increased above its normal value, an increase of armature current and incidentally, also, an increase of line current, will result. Apparently under or over-excitation of the field will result in a greater

consumption of energy without additional load on the motor. This, however, is not the case. If, at the time of obtaining the phase characteristic readings, power factor readings are also taken and plotted curves such as shown by dotted curves '1, '2 and '3, are obtained, thus indicating that even though the line current becomes excessive, the actual energy consumption is but little more at extremes of excitation than at normal excitation. At high values of line current, the power factor is necessarily extremely low.

Curves 1, 2 and 3 are representative of such as might be obtained under zero, half and full load conditions,

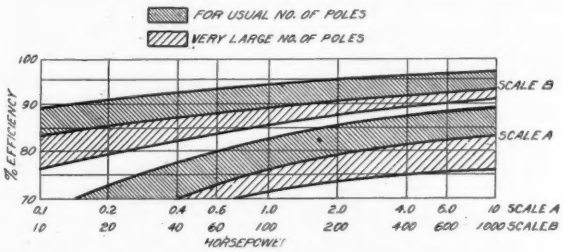


FIG. 8. EFFICIENCIES OF AVERAGE INDUCTION MOTORS

with corresponding power factor curves '1, '2 and '3, respectively.

Induction Motors

Essentially the induction motor is, throughout its range of capacity, a constant speed machine. If, however, such a motor is loaded beyond its rated capacity, its speed will decrease up to a definite point, after which further decrease in speed, with corresponding decrease in horsepower output, will result until the machine is brought to standstill. This characteristic is well illustrated in Fig. 7, showing characteristic curves of a 5-hp., 3-phase, 6-pole, 220-volt induction motor.

Maximum efficiency is not reached until the motor carries full load, after which it gradually decreases to maximum output, followed by an abrupt decrease until at standstill it becomes zero.

The power factor curve up to maximum output follows closely the efficiency curve, although beyond this

Motor voltage in per cent line voltage	Line starting current in per cent of full load current	Motor starting current in per cent of full load current	Starting torque of motor in per cent of its full load running torque
40	112	280	32
60	250	420	72
80	450	560	128
100	700	700	200

FIG. 9. STARTING CURRENTS REQUIRED BY 3-PHASE SQUIRREL CAGE INDUCTION MOTORS

point its decline is not nearly as marked as that of either the power factor or the speed.

Horsepower and line current curves are of the forms indicated.

Curves indicating the friction losses, core losses, primary copper losses and secondary copper losses are representative of those applying to a 5-hp. machine, although, due to the fact that the smaller the number of poles and the higher the frequency, the higher is the efficiency, these curves vary somewhat with different designs.

Efficiencies of average induction motors are, as shown in Fig. 8, taken from the Standard Handbook for Electrical Engineers, as is also the table, Fig. 9, giving the currents taken by 3-phase, squirrel-cage induction motors at the moment of starting.

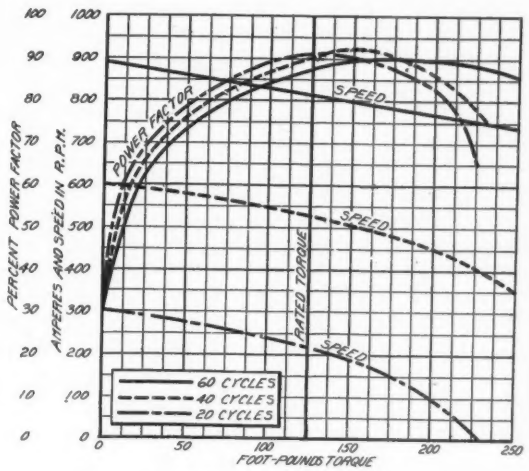


FIG. 10. EFFECT OF CHANGE OF FREQUENCY UPON PERFORMANCE OF A 20-HP. INDUCTION MOTOR

By the introduction of a variable resistance in the rotor winding circuit of a wound-rotor type of induction motor, the speed of such a machine may be varied within a wide range. The effect of such a scheme upon the performance of a 20-hp. motor is illustrated by the curves shown in Fig. 11.

Where change of speed is accomplished by means of altering frequency of the supply voltage, correspond-

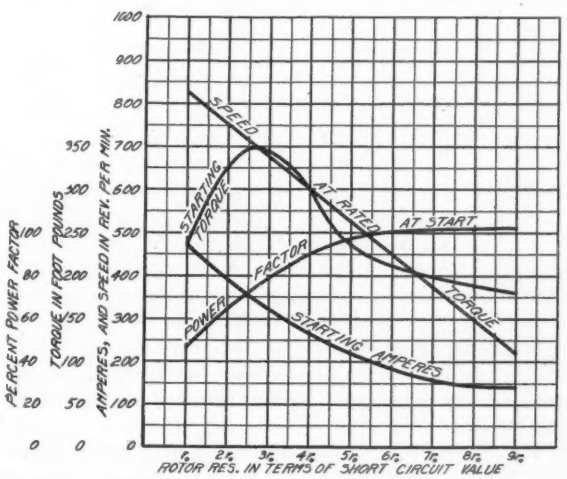


FIG. 11. EFFECT OF CHANGE OF RESISTANCE OF ROTOR CIRCUIT UPON PERFORMANCE OF A 20-HP. INDUCTION MOTOR

ing power factor, speed and current variations will be as indicated in Fig. 10.

(To be continued.)

If you would be wealthy, think of saving as well as getting.

Starting 3-Phase Induction Motors Without Compensators

STAR-DELTA METHOD OF STARTING INDUCTION MOTORS FROM 5 HP. TO 50 HP.

STARTING 3-phase induction motors ranging from 5 hp. up to 50 hp. without employing any means such as a starting compensator for reducing the starting voltage is made possible by what is known as the star-delta method employed by the Robbins and Myers Co.

The motors are furnished with the ends of each phase of the winding brought out so they can be connected in Y for starting and delta for running by a connecting switch. The motors are regularly wound to give their normal operating characteristics with the windings connected in delta. This arrangement makes it possible to start the motor without the compensator. With this arrangement, according to the manufacturers, a starting

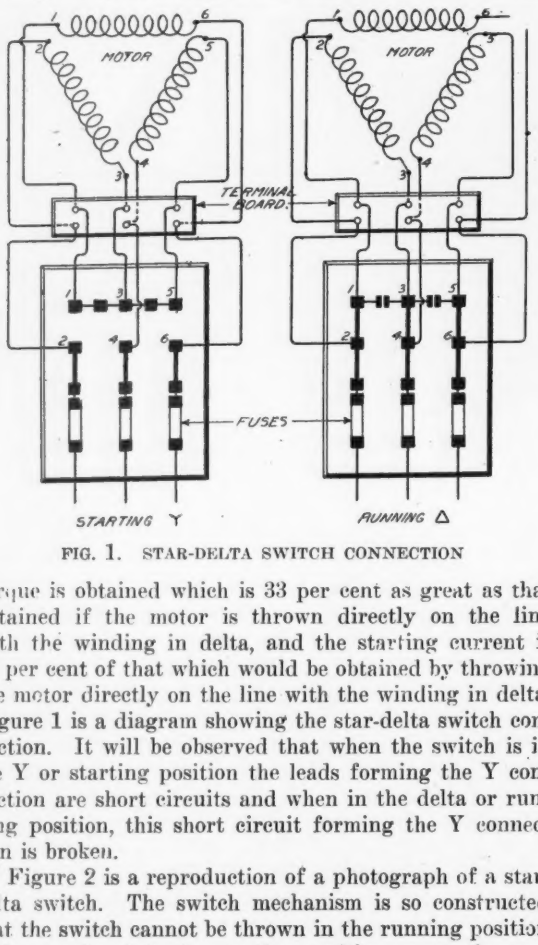


FIG. 1. STAR-DELTA SWITCH CONNECTION

torque is obtained which is 33 per cent as great as that obtained if the motor is thrown directly on the line with the winding in delta, and the starting current is 57 per cent of that which would be obtained by throwing the motor directly on the line with the winding in delta. Figure 1 is a diagram showing the star-delta switch connection. It will be observed that when the switch is in the Y or starting position the leads forming the Y connection are short circuits and when in the delta or running position, this short circuit forming the Y connection is broken.

Figure 2 is a reproduction of a photograph of a star-delta switch. The switch mechanism is so constructed that the switch cannot be thrown in the running position without going into the starting position, as can be seen in the illustration. A is a spring for assuring quick break when throwing the switch out. B is the locking arrangement holding the switch in the starting position or Y, giving the motor ample time to come up to speed. By shifting the handle slightly back the lock allows the switch to be thrown in the running position or delta connection.

The locking device for checking the switch in the starting position consists of a spring clip attached to one side of the middle back contact. A pin on this clip, B, is caused to pass through a hole in the contact by a cam on the switch blade, thus preventing the switch from passing the starting position until the switch blades are backed a slight amount to allow the spring clip, B, now released by the cam, to draw the pin out of the hole in the contact and permit the complete closure of the switch to the running position.

It will be noted at C, that when the switch is brought in the starting position, the entire front section is connected, forming the Y, and when the switch is thrown into the running position, the blades are in contact with clips D, thus forming the delta and breaking the Y.

F is an insulated support for holding the blades in line. E is one of the contacts, of which there are three connecting the motor terminals in the starting and running position. G is one of the switch blades, of which there are also three, when the line is connected.

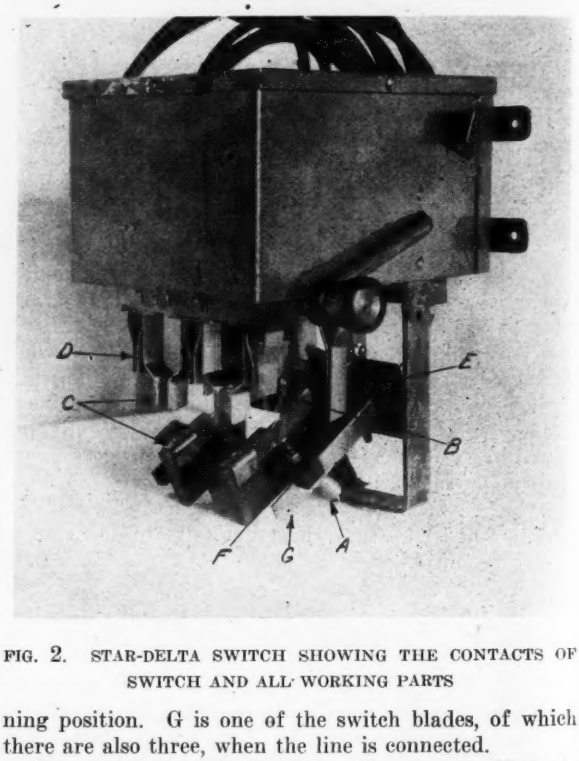


FIG. 2. STAR-DELTA SWITCH SHOWING THE CONTACTS OF SWITCH AND ALL WORKING PARTS

The switch is submerged in oil so as to eliminate arcing when in operation.

All connections are made to the nine leads brought out of the cover through bushings.

Concentrating Electric Power Stations

SOME proposals have been made that, in future, generation of electric current be concentrated in a few large power centers, either at the mines or in central locations, power being transmitted from them to towns and cities for local distribution.

The following thoughtful comment by Engineering of London is well worth consideration in this connection.

The two reports on Electric Power Production have prepared the public mind for the creation of a number of super-power stations as soon as the more important

demands for munitions have been satisfied and engineers can apply themselves to the production of the necessary machinery. Nothing can be more advantageous to the reorganization of the country on a peace basis than a plentiful and cheap supply of power in all our towns and villages. But many people have formed an exaggerated idea of the cheapness at which electric energy can be delivered from large turbo-generators and enormous stations; and Mr. Ernest Hatton was well advised, in his presidential address before the Municipal Tramways Association Conference recently, to utter words of caution against the popular idea that electricity can be supplied for nothing, or next to nothing.

That large stations, situated in suitable localities, can turn out energy at low figures is certainly true, or rather it was true before the war. But the figures quoted have usually been the cost of energy at the switchboard, and not at the terminals of the consumers' motors. It is remarkable that although electricity is invisible and imponderable it is very costly to transmit over long distances.

Time and again it has been shown that it is cheaper to carry coal by rail to the generating station than to place the plant at the pit-head and carry the current by wires over long distances. Distribution adds much to the original cost, and if it entails two or more transformations these have also to be paid for. The new stations will be built with dear materials and dear labor, and the capital charges will be high. Generally the distribution will be in the hands of municipalities, who must add to the price the capital charges resulting from the sacrifice of their existing plant.

Mr. Hatton said: "Any scheme of general power supply, if it is to be a success, must, within a reasonable period, by its more economical working and production on a large scale, be able to carry on its back the annual charges upon the plant which will be superseded or closed down by its adoption."

In the smaller towns this burden will often be serious, for it is well known that the plants have often not been written down as they should have been. There is plenty of obsolete machinery that will never go round again, but which is kept in the stations so that it may figure as an asset in the balance sheet. Sometimes the business has not brought in sufficient returns to allow of drastic writings-off, and sometimes the money has been unwisely used in the reduction of the rates. Whatever be the reason, interest and amortization have still to be paid, and unless the burden be placed directly on the rate-payers it must be carried by the new concerns.

They will be much in the position of the electric traction companies who bought out the horse tramways, paying long prices for "two streaks of rust and a right of way." This was generally the case with the private companies; the municipalities often obtained their local lines at the "then" value, which was very small. However, if the electric supply should cost more than many expect, it will only resemble other things in this respect. The purchasing value of money has fallen immensely, and it will take many years of peace to re-establish it on the old footing.

BEWARE of small expenses; a small leak will sink a great ship.

Electricity Has Won the War

BY SIDNEY NEU

ELECTRICITY has played no unimportant part in the winning of the war. Only on the battlefield has the work of the electrical engineer not been apparent—poison gas, liquid fire, shrapnel, explosive shell, machine guns, rifle bullets, bayonets and men that fought like demons showed no signs of the presence of electricity. Yet were it not for electricity and man's control of its use these forces of victory had not been.

Could the gunsmith of a century ago have armed an army of 4,000,000 men in 18 months? With 4,000,000 men withdrawn from production, could any army have been equipped? Electrically driven machine tools made possible what human sweat and muscle never could have accomplished.

Unheard of tons of steel have been required, and those best able to judge have said that without electric drive to speed production in the mills we should have fallen short.

Uniforms were needed to clothe the men who fought. They could not go naked while weavers leisurely wove the cloth, cutters shaped it, and tailors sat cross-legged slowly stitching seams. Electricity was called on to do these things with speed, and the uniforms were made—breeches, shirts, leggings, shoes, underwear, hats, belts, millions of them.

Of these things, some were doubtless made by steam power unaided; but where production was the swiftest and therefore the most effective, electric drive was responsible.

Chemicals that speeded the shells on their way, that burst the shell to fragments, that made the very air untenable for the foe, owed their production in the tremendous quantities required to electricity. Electrochemical processes fashioned some, electric drive furnished the controllable mechanical power for making others.

The army and the nation needed food and electricity produced it. Fertilizers produced by electrochemical means made the earth productive, electric drive threshed much of the wheat, prepared the meat, operated the packing plants, ground the flour, entered everywhere into the production of food to make human labor less and to release more men to carry fear to the hearts of barbarians.

In its gentler aspects electricity appeared even on the field of battle, guiding armies, battalions, even individual shells. The airman by his wireless telephone and telegraph guided the gunner far to the rear who would otherwise have been blind. The commander watched through his wire and wireless network the progress of his fighting units miles away, kept them correlated into one vast machine that acted as a whole, not as a multitude of unrelated parts.

Billions of electric sparks daily ignited the cylinder charges of motor trucks, lorries, airplanes, motor cycles and the victorious tanks. Without electricity for ignition, these engines would have been unheard of.

Electricity enabled the ships at sea, with their precious freight of American manhood, to keep each other in touch, to avoid the hidden dangers that menaced, to signal back as each arrived, "We're here, and safe!"

The ships themselves—did not electricity produce them? Their plates were rolled and shaped and machined in electrically driven machinery. Electric cranes transported their parts, electric compressors furnished the power behind the busy riveters.

Speed won the war when it was won and saved millions of human lives and untold additional human suffering—America's speed. The world marvels at America's speed and even America marvels. America was capable of this unheard of speed because America has made electricity its servant. Many men have been needed to accomplish what has been done in preparation, but at least twice and probably three times as many men would have been needed had not electricity been ready to help; and there were not that many men.

Electric light in battlefield searchlights patrolled the sky and no man's land, guarding against surprise. At home protective electric lighting dispensed with many human guards who thus could lend their hands to much needed production. Within the busy plants men worked through the long hours of night as swiftly as by day, because electric illumination was at hand.

So short was the man power that even with electricity's help women were required to lend their aid in making ready our fighters' equipment. Without electricity women's help would have been but feeble. It is because electric drive tames rough forces and makes cumbersome machinery so simple to manipulate that it was possible for women to do what only men had done before. Work with machinery had been considered man's exclusive sphere because it had been rough work, heavy work. Electricity has made it such light work that it no longer fatigues the frailer sex.

Nor is this alone electricity's part in putting women at the lathe, the punch press and the planer. It has simplified the home so that she can be spared. We forget the duties that women formerly had in the home. She was spinner and weaver and tailor; she was laundress and housemaid, baker and cook, milkmaid and charwoman. Electrical machinery and electrical transportation have taken many of these duties out of the home. Those that are left, washing, ironing, sweeping, cooking and sewing, electricity has so lightened that women have been able to take their part in saving the world for those that dwell in it. Where many women were needed in the "good old days" to keep one household running smoothly, one alone now finds time to spare.

Trace back to its source anything or factor that has helped to end the struggle and electricity is found, not once but many times, to have touched it and hastened it on to consummation. Truly, electricity has won the war, electricity guided by American brains, led on by American energy, crowned by American valor.

In regard to Liberty fuel, which has been much exploited in the newspapers and magazines, the Fuel Administration states the U. S. Army laboratory tests show it to be about 65 per cent benzol, 30 per cent kerosene and the balance amyl acetate, napthalene, alcohol and some undetermined constituents. As benzol is the chief element, the supply of Liberty fuel must depend on the supply of benzol, of which the total available is 3500 bbl. a day. Using all this, which cannot be done, the Liberty fuel made would be about 2 per cent of the present gasoline output.

Care of Cup Leathers

Precautions in Ordering and Storing; Preserving Used Packings. By Charles W. Peirson*

THE care and use of cup leathers is a matter that has been given very little thought, considering the large quantity of leather packings used for various purposes.

Leather packings cannot be expected to give maximum service unless they are made from the proper kind of leather and made the proper size. It seems to be the opinion of many users of leather packings that all that is necessary, in ordering new packings, is to take dimensions from an old sample, or send the old sample to the packing manufacturer.

Owing to the fact that leather packings shrink considerably after having been in use, it is impossible to take dimensions from these old samples with any degree of accuracy; consequently, it is of the utmost importance that the diameter of the cylinder, or stuffing box, as well as the diameter of the piston, or ram, on which the packings are to be used, is carefully calipered and these dimensions specified on the order for the packings.

It is a common practice, on the part of many users of leather packings, simply to order so many packings as "per sample;" and some packing manufacturers, rather than lose the order by insisting on the dimensions, will take a chance. Consequently, the packings frequently prove unsatisfactory and the user is put to a great deal of inconvenience.

In ordering "U" packings, sometimes known as "double cup leathers," the two most important dimensions are the outside and inside diameters and, unless these are given accurately, the packing cannot be expected to give efficient service. The depth does not vitally affect the efficiency of the packing, but it is important, in that the depth must be right or the packing will not fit as well as it should and may cause trouble on installation.

In the investigation of complaints, we have found that in many cases the packings have been made too deep and, as a consequence, have been crushed before any pressure was applied to them.

In the case of flange packings, sometimes known as "hat" packings, the inside diameter is the most important. The outside diameter and depth are important also, but a slight variation in either would not affect the efficiency of the packing.

In ordering cup leathers it is very essential that the inside diameter of the cylinder be given, because this represents the outside diameter of the cup leather.

Many users of hydraulic machinery, as soon as leakage or other trouble is experienced, are prone to condemn the packing, although investigation of hundreds of complaints has shown that the packing is very seldom at fault. It has either been ordered the wrong size, has been improperly applied, or damaged when being applied. Mechanics have frequently been seen driving leather packings into place with a hammer and cold chisel or by some other equally destructive method.

The care of cup leathers is an important factor in their efficiency; because no matter how well a manufacturer may make them, if they are not properly cared

* Engineering Division, Leather Department, E. F. Houghton & Co.

for, they are liable to lose their shape or become damaged to such an extent that they either cannot be used, or, if they are used, give trouble.

It is not unusual to go into some of the largest plants using thousands of dollars' worth of leather packings, and find that the packings are given no more care or attention than a piece of old rope. They are thrown indiscriminately in a box with a lot of tools, and large "U" packings are frequently found hanging on pegs or nails, which makes them lose their shape. Also, they are frequently kept under atmospheric conditions anything but beneficial to packings.

Some leather packing manufacturers go to a great expense to place their packings in the hands of the consumer in paper or cardboard cartons, or put up in some way that will preserve their shape and condition.

Leather packings should be kept in a cool, dry place, and in containers to prevent them from becoming damaged. In the case of large "U" packings, it is recommended that semi-circular forms be used to hang them on, similar to that which a bricklayer uses in making an arch over a doorway.

In some industries, it is customary to use packings for only a few months out of the year, covering a certain season of operation, and these concerns desire to keep these packings in proper shape until they are needed again. We infer that this is the case in the plant in which the writer of the query in the Nov. 1 issue is employed.

As stated above, however, after a leather packing has been in use and removed and allowed to dry out, it will shrink considerably—sometimes to such an extent that it is almost impossible to use it again. About the only way this can be prevented is to have a sufficient number of molds or forms made into which the packing can be placed immediately upon its removal from the machine.

These forms can be made of cast iron or cold rolled steel, whichever is most readily obtainable. As a last resort, they could be made of wood; but wood is not recommended because of its tendency to shrink. Iron or steel forms are everlasting, while the wood forms are not.

It is true that cup leathers once dried out and shrunk will not return to their original size with soaking, and it is better to throw the cup away than try to use it again. It is also true that most leather packings, upon being removed and placed in water and allowed to stay there, would deteriorate and rot to such an extent that they would be practically useless. Furthermore, they would lose their shape. This, however, does not apply to packings made from mineral tanned leather; and although such packings would lose their shape if allowed to remain in water for any length of time with nothing to hold them in shape, the water would not rot the leather or cause it to deteriorate; and it is for this reason that mineral tanned leather packings have so far superseded oak tanned leather packings for high pressure service.

Government Operation of Public Utilities---II

LACK OF SELF-INTEREST AND STANDARDS OF EFFICIENCY. BY F. B. DEBERARD

THE MOTIVE of self-interest is dominant in all industrial enterprises. It induces the investment of capital therein; it permeates the directorate and enlists the careful attention and best energies of its members; it operates powerfully to develop executive officials of the highest ability and to secure the assiduous devotion of that ability to the efficient and profitable management of the properties. It secures similar zeal upon the part of all minor officials, and induces faithful and diligent service by the rank and file of employes.

This incentive of self-interest proceeds from the system of promotion which prevails in private employment; namely, free selection by the higher officials from the ranks of their respective subordinates, of those who prove themselves best qualified for more important duties. Efficiency and economic value are the tests. Under such a system, the opportunities are numerous; the rewards in the form of salary increase are substantial; and the best energies of every worker are enlisted to promote the interests of the business.

Contrary conditions prevail in governmental service. To prevent political abuses, the Civil Service Laws were enacted to regulate the conditions of selection and promotion. These laws have succeeded in greatly reducing the political abuses indicated, but they have caused another class of evils. While they have given security of tenure to employes, they tend to retain in place the relatively inefficient as well as the deserving, and they deprive the executive of the power of choosing for promotion the men best qualified for more important duties. The higher places, moreover, not being under the operation of the Civil Service Laws, are still open to appointments by favoritism and political influence, and the great stimulus of opportunity to fill these higher places is thereby taken away from the rank and file, who are reduced to discouragement and to the performance of duty in a perfunctory way, by reason of the absence of an incentive, of which they are deprived by existing conditions.

Absence of self-interest as an incentive degrades the standards of personal efficiency in the governmental service. It is difficult to secure in the higher administrative positions the services of men of first-class specialized ability, by reason of the low salaries paid by the government as compared with those paid by large corporations; by reason of the insecurity of tenure; and the hampering conditions already explained, which prevent able men from being fully effective.

In the lower ranks, while the employes are commonly paid more than similar work commands in private enterprises, there is small opportunity to rise and little or no reward for exceptional ability. Under these conditions, the best and most ambitious men eventually leave the government employ, and thereby reduce the general level of capacity of the entire body of employes and place it upon a much lower plane than prevails in private business.

Lack of Standards of Efficiency

A high standard of efficiency on the part of every employe is a chief concern in all private business. In manufacturing undertakings, especially, it is vital to continued existence, for competition would soon wipe out any corporation whose labor costs were excessive. To control this important element, tasks are minutely sub-divided and careful records are kept of the time required for and the output of every separate operation. The extent of the work which should be performed by every employe is thus developed and all employes are held to the fixed standards. Labor costs are thus held to a minimum and the due productivity of every employe assured.

These industrial methods are seldom employed in governmental work. The cost of caring for public buildings is commonly more than twice the cost in the case of private buildings. When streets are repaired by government labor, the cost is usually excessively great. In public offices the cost of clerical services, when tested by the work performed, is usually several times that of similar services in the case of large corporations.

Standards of efficiency of government employment are materially lower than those of private employment. The rate of wages for minor employes is materially greater; the hours of labor are materially shorter. These factors combined result in excessive labor costs for all government undertakings. If the public utilities of the country are taken over by the government, there will be somewhat more than three million government employes. Let this number be multiplied by the difference between the labor costs of government work and private work, and a formidable aggregate increase in labor costs would result, probably fully equal to the profits now accruing from private investments in public utilities.

Political and Financial

There are at present approximately 2,000,000 railway employes in the United States. Other public utilities, including telephones, telegraphs, electric light plants, urban and interurban electric railways, other street railways, water transportation lines and express service, will raise the aggregate number of employes who would ultimately enter some form of governmental employ under government operation of public utilities to about 3,000,000 persons.

No proper consideration of this subject can ignore the political dangers which might readily arise from this source. Senator Bourne points out that in the last ten presidential elections the President has been elected by a plurality varying from 7000 plus to a little more than 2,500,000. A body of government employes numbering 3,000,000 intent upon better pay, less service, shorter hours, and other personal advantages, might readily hold the balance of power between the principal opposing political parties, and make the choice of a President and the policies and methods of government dependent upon concession of demands made by an organization of government employes.

Outstanding securities of the railroads, together with their unfunded debt, are now in excess of $20,000,000,000. The aggregate securities and unfunded debt of other public utility corporations are approximately $8,000,000,000, total of $28,000,000,000 of invested capital represented by stocks and bonds, which would have to be refunded and substituted by National, State or Municipal securities if public utilities be governmentalized.

One argument invariably advanced in support of government ownership and operation is the saving in interest charges due to the superior credit of governments. It may be assumed, therefore, that the outstanding corporation securities which now return interest or dividends at the rate of from 5 per cent to 8 per cent would be substituted by government bonds carrying interest at 3 per cent.

No refunding operation equal in extent and danger to this has ever been undertaken. To reduce suddenly the earning power of $28,000,000,000 of capital by more than one-half would probably produce a financial cataclysm, and would certainly profoundly disturb the entire financial and economic structure of the country. Possibly some safe means of effecting the enormous refunding operation indicated might be found, but the dangers attendant upon it should not be overlooked.

Railroads of the country now contribute to the cost of government more than $150,000,000 each year in the form of taxes. The taxes paid by other public utilities would probably increase the total to over $200,000,000. The funds derived from these taxes accrue to the several states, municipalities, or other political divisions where the property is located. In the event that these utilities become the property of the Federal government, they would no longer be subject to taxation and the several states, and their inferior sub-divisions, would thereby be deprived of a principal source of revenue from which to meet the expenses of government. One result, therefore, of government ownership of public utilities would be that other forms of property would have to bear a materially increased burden of taxation.

Conclusion

Defects of government procedure in economic undertakings have been outlined. Those defects are ineradicable because they are rooted in our political institutions. The principles that govern political action and those that govern economic action are fundamentally different and cannot be reconciled.

The preceding survey of the field thus shows in the governmental operation of public utilities defects which are insuperable obstacles to economic efficiency. Those defects proceed from and are rooted in the political principles upon which our form of government is based. The American people believe that nothing should be done except that explicitly authorized by the representatives of the people. They believe that liberty and civil rights will be subverted unless public officials be frequently changed. They believe that the powers of such officials should be severely limited, that their discretion should be restricted to the uttermost, that they should do nothing until the legislature shall have given its assent and prescribed the manner of doing.

But the methods which are the inescapable result of these principles are repugnant to and destructive of good management of business affairs. These methods when applied to the field of economics are deadly blights. To subject to their demoralizing and destructive influ-

ence such vital elements of the national industrial life as the railroad, telephone and telegraph systems of the country would almost certainly impair to an extreme degree the usefulness of those invaluable public instrumentalities, and prove an immeasurable misfortune.

Continue Coal Economy

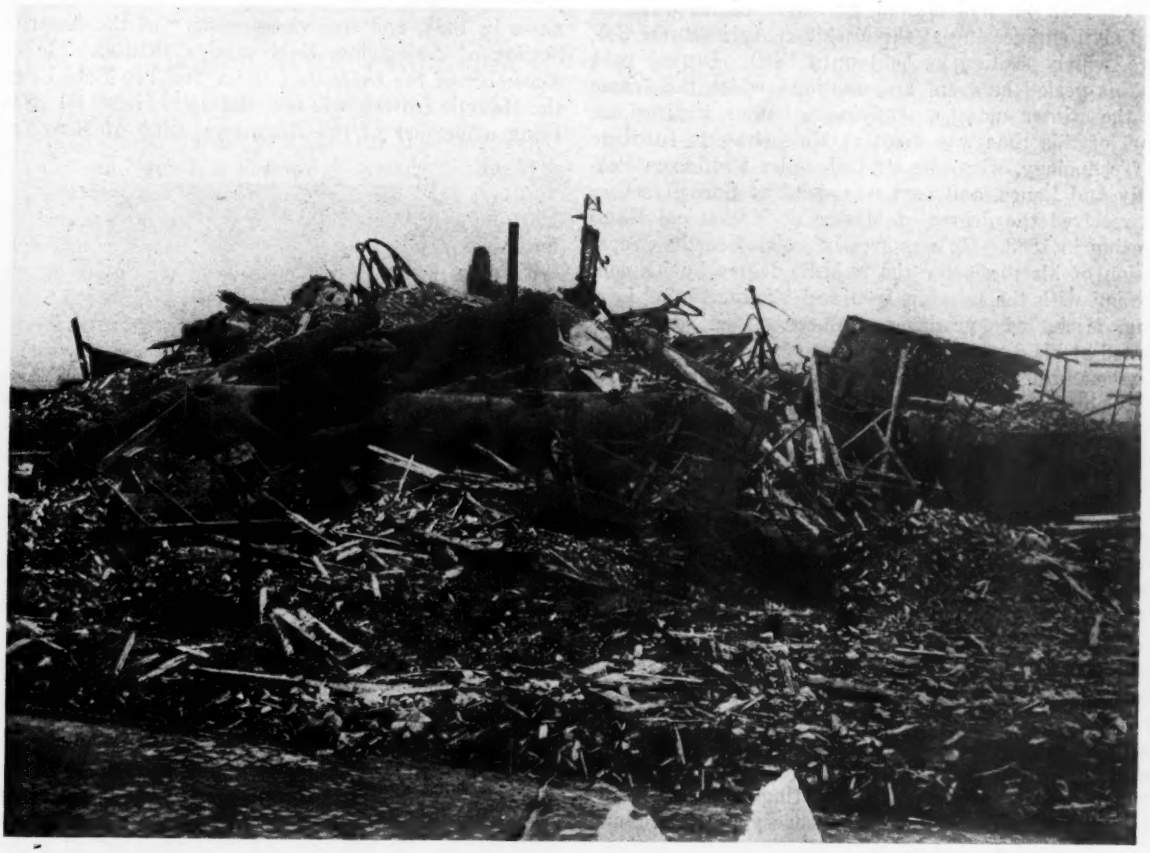
Devastated Coal Mines of France Affect World's Fuel Supply

IN their drive into France the Germans struck directly at the source of industry of that country—the coal mines. They held this mine country as long as possible; there was no strategic play over this ground as in some other districts. Only when forced by superior arms did the Germans release the coal mines which they had continued to work at highest capacity during their occupation of the territory. Then, as has been their unvarying policy in warfare, they destroyed the mines and machinery as far as dynamite could do the work.

An idea of the completeness of the systematic destruction of the famous coal mines at Lens, France, is given by the accompanying illustration. All the working plant, winding gear and ventilating machinery were destroyed and the mine galleries flooded. A French commission which visited the mines shortly after the Germans left estimated that it will be from 2 to 3 yr. before the mines can be put back into working condition.

One of the factors which caused a shortage in the coal supply of the world was the fact that this coal region was occupied by the Germans. Now, due to the destruction which was carried on during the retreat of the Germans, this factor still exists and along with it the need for economy in the use of fuels which must be used in the industries called upon to replace the machinery and equipment necessary to put these mines back into working condition.

The Germans should be forced to make good the losses to property they have caused in this devastated region; but even if they are, the people of the entire earth will be compelled to stand losses due to higher prices for fuels and metals used in the reconstruction of the destroyed industries.



WRECKAGE OUTSIDE OF PIT 4 OF THE LENS, FRANCE, MINES. PHOTO BY INTERNATIONAL FILM SERVICE, INC.

Don't forget the lessons in economy learned at great cost during the war period. Their value is just as great, if not so urgent, during the years of reconstruction and peaceful pursuits as during the strenuous times of war. SAVE COAL.

TESTS OF Liberty fuel in various government laboratories show no corrosion of the engine or parts, but a great amount of gumming up, considerable fouling of spark plugs, crystallization of the fuel at 15 deg. F., and boiling at 175 deg. F. This would indicate more likelihood of trouble in cold weather and greater difficulty in starting than with gasoline.

Rolla C. Carpenter

PROFESSOR CARPENTER was born near Orion, Mich., June 26, 1852, one of a family of seven children. He received his early education in the district school and in the Pontiac High School, then entered the Michigan Agricultural College, from which he received the degree of Bachelor of Science in 1873.

He received the degree of Civil Engineer from the University of Michigan in 1876; and was then engaged as an instructor in the Michigan Agricultural College, at the same time doing graduate work, until he received the degree of Master of Science in 1876. He was married to Miss Marion Dewey at Greenville, Mich., May 25, 1876.

In 1878 he was elected professor of mathematics and civil engineering at the Michigan Agricultural College, which position he held until 1890. During part of this period he spent his vacations, which then came in the winter months, studying at other institutions. Part of this time was spent at Massachusetts Institute of Technology, where he studied under Professors Peabody and Lanza, and part was spent at Cornell, where he received the degree of Master of Mechanical Engineering in 1888. He was greatly assisted in the preparation of his thesis for the M.M.E. degree by his connection with the Lansing Iron and Engine Co. of Lansing, Mich., as consulting engineer. This connection placed at his disposal the facilities of a large and up-to-date manufacturing plant which offered opportunities not then enjoyed by any of the technical schools. This thesis, which is now on file in the Cornell University Library and which was reported upon by Dr. Thurston in a paper read before the American Society of Mechanical Engineers, was on the subject of Internal Friction in Non-condensing Engines and, as shown by Dr. Thurston's discussion, played an important part in the entire revision of the then prevalent ideas about steam engine friction.

In 1890, Professor Carpenter was elected Associate Professor of Engineering at Cornell University, and the laboratory work was organized as a separate department under his direction. In 1895 he was elected Professor of Experimental Engineering, which position he held until June, 1917. He then retired from active teaching, but continued his consulting work, especially in coke manufacture and the recovery of by-products of that industry.

Professor Carpenter's experience in the several leading educational institutions, as well as his intimate contact with various industrial enterprises, peculiarly fitted him for the work of building up a course of instruction in experimental engineering which has done much for the upbuilding of the reputation of Sibley College and which is regarded by many alumni as furnishing a most valuable part of their education.

Professor Carpenter published his Notes on Mechanical Laboratory Practice in 1891, and this was the basis of his later text-book on Experimental Engineering, which has been the leading manual in this country on the subject. His book on Heating and Ventilating Buildings has gone through six revisions and has had an extensive circulation. It contains much original material from the author's own experience and is much quoted by later writers on heating and ventilating. Professor Carpenter was also joint author with Professor Diederichs of a text-book on Gas Engines.

In addition to these books, he has made many contributions to engineering literature through various societies and publications, among which may be mentioned the American Society of Mechanical Engineers, the American Society of Civil Engineers, and the American Society of Heating and Ventilating Engineers.

Professor Carpenter was a member of eight of the leading engineering societies of America, was vice-president of the American Society of Mechanical Engineers from 1908-11 and served on various committees of this society, perhaps the most important of which was the Boiler Code committee. He was president of the American Society of Heating and Ventilating Engineers in 1898, and was vice-president of the American Society of Automobile Engineers in 1910-12. He was a member of the Delta Tau Delta, the Tau Beta Pi and the Masonic fraternities, and also active in social affairs being a member of the Engineers' Club of New York

City, the New York Railroad Club, the Town and Gown Club of Ithaca and the Alpha chapter of the Sigma Xi of which he was president in 1912-1913.

Professor Carpenter engaged in a diversified field of investigation and research including problems relating to power plants, gas engines, cement manufacture, coke manufacture, railway management, heating and ventilating. He was one of the greatest patent experts in the country and was employed by many of the leading law firms in various parts of the United States. He invented a number of pieces of laboratory apparatus, such as the Carpenter coal calorimeter, which was for many years a standard for testing the heating value of coal, the throttling and separating steam calorimeters now extensively used, a friction testing machine which may be found in most of the large laboratories and an inertia governor for the steam engine.

His life has been brimful of activity. He was honored by appointment to various positions of distinction; was judge of machinery and transportation at the Chicago Exposition in 1893, at the Buffalo Exposition in 1901 and at the Jamestown Exposition in 1907. He was a member of the commission appointed by the Academy of Science in 1915 at the request of the Presi-

dent of the United States to investigate the slides at the Panama Canal and to make such recommendations as in the judgment of the commission would improve the conditions and lessen the possibilities of slides in the future. He received the degree of Doctor of Laws in 1907 from the Michigan Agricultural College.

Professor Carpenter's kindly manner and genial disposition made it easy for even the most timid to approach him, and he was never too busy to be considerate of anyone who sought his council and advice. His large and varied experience, coupled with good judgment and his extensive knowledge of the engineering profession and of human nature, made his council and advice exceedingly valuable to his colleagues as well as to students and the world at large, and many whom he aided will be saddened by his death, which occurred at Ithaca, N. Y., on Jan. 21.

Gas Formation in an Ammonia Absorption System

TESTS by the Bureau of Standards have shown that the gas formed in absorption systems is usually a mixture of hydrogen, nitrogen and oxygen. That the presence of hydrogen in considerable quantities, which can be burned in air after the gas is passed through water, indicates the presence of impurities which have formed carbon dioxide, and considerable corrosion will result.

The cure is the addition of sodium bichromate to the liquid in the proportion of 0.2 per cent of the weight of the ammonia liquor.

If the gases are largely nitrogen, which is inert, and will not burn in air, with some oxygen, air leaks into the system are indicated and these should be hunted out and sealed. If the composition is intermediate, both troubles are present and should be remedied.

As to the use of zinc as a preventive, to attract the corrosion rather than the iron, it was pointed out that zinc oxide will be formed and deposited as a white powder and hydrogen will be released into the gases. The same action will occur if pipe galvanized on the inside is used in an effort to prevent corrosion. Hence, galvanized pipe should never be used in either absorption or compression systems for the ammonia lines. The zinc oxide may be white or may have a greenish color due to traces of iron. In some instances, there has been a reconversion and metallic zinc has been deposited out in other parts of the system.

If an ammonia charge is used in which a considerable amount (0.6 per cent)of carbon dioxide is present, either from impurity as charged or from concentration during use, oxygen will attack the iron pipes forming a sludge of black oxide of iron mixed with free carbon. The addition of the sodium bichromate seems to form a coating which protects the iron surfaces from oxidation, but the exact nature of the coating seems to be in doubt. Cast iron, particularly if the sand scale has not been removed, is much less subject to corrosion than wrought iron or steel, but different qualities of cast iron vary considerably in this respect.

WITH THE price of leather at a very high price, an inspection of belts will pay for itself in a short time.

Employment for Returning Soldiers and Sailors

EVERY employer can be of real service to the returning soldiers and sailors by offering them employment.

In order to centralize the effort, an employment bureau in the Chicago district has been established under the direction of a National Council, Red Cross, Y. M. C. A., Army, Navy, commercial, church, labor, farm and other Chicago organizations and has available for industrial enterprise the nation's choicest manhood. Not only are these men physically fit and strong and full of initiative, but they have quick military snap, yet orderly power, the result of organized training and discipline.

Aside from the advantage the employer has in getting men of high quality, by placing his orders for help with the bureau he also does his share toward providing a means for the returning men to make up in part for the small pay and many hardships which they have experienced during their period of service. The U. S. Employment Service has established these bureaus for returning soldiers and sailors not only in Chicago, but at other principal points throughout the country, and our readers who reside at other points than Chicago should make use of their local bureaus. Orders for help from the Chicago district should be addressed to the Bureau for Returning Soldiers and Sailors, 58 W. Washington St., or telephone Randolph 7140.

MANUFACTURING INTERESTS throughout the country are becoming impressed with the vital necessity of properly safeguarding the lives and health of employes, not only from the viewpoint of the new humanitarism, but from a sense of business foresight.

The demand upon the newly established Working Conditions Service of the U. S. Department of Labor, for industrial physicians and surgeons, has grown so rapidly that the service has been compelled to establish a bureau of registry of physicians specially skilled in this growing phase of medical and surgical specialization.

The new registry bureau is prepared to furnish industries with the names of skilled industrial medical advisers on request. In each instance the service satisfies itself of the training of the physicians before their names are allowed on the list. Thus only those best qualified are listed, and manufacturers have the advantage of knowing that by availing themselves of this service their dispensary section will be in competent hands.

In addition to submitting names from the physicians' registry bureau, the service is making investigations—only on request, however—of the general facilities for protecting the lives and health of employes. This work is carried on from branches of the service now being established within easy reach of the nation's industrial centers. When such surveys are concluded, a report of the findings, with recommendations, is delivered to the responsible head of the particular industry. In this manner industries are assured reliable and unbiased information from authorities who have studied industrial problems exhaustively, with expert training in hygiene, sanitation and related subjects.

Analyzing Station Fuel Costs

By H. S. Knowlton

THE increased cost of fuel has made analysis of power plant production cost more significant than ever. It behooves every engineer having access to such data to make the most of them, especially in these times when efficiency of operation is so important a factor in the continued service of different installations. It is surprising how extended an analysis can be prepared for exhibition on a single letter-sized sheet on the basis of a few fundamental data from a plant covering two compared periods. We must know the total kilowatt-hour output for each period, the fuel consumptions, the average price of coal or else the total cost of fuel, and the total so-called "manufacturing cost" in each case; and if we add to these data the cost of labor and the peak loads handled in the two periods, four more items, we have all the material for a really illuminating study. With a slide-rule and a little extra time one can then work out comparisons which are sure to prove valuable.

What are some of the significant points which may be brought out on the basis of the above total data? The cost of production per kilowatt-hour of course comes in the first rank of importance. Thus, in one instance, it was desired to study the effect of an increase in the cost of coal upon plant expense. In a given station the output last year was about 22,000,000 kw-hr. compared with 33,000,000 this year, a war-time increase in a large plant handling a rapidly growing munitions establishment load. The cost of coal per ton rose from $5.12 to $8.28 in one year, and this was a tidewater station, too. The actual coal consumption last year was 20,836 tons and this year the load increase was cared for with a gain in coal consumed of only 7576 tons. The total cost of production at the bus was $297,481 this year as against $151,577 the year before. The station labor cost last year was $24,768 and this year $31,708. The peak loads of the two years were 8800 and 11,300, kw. respectively.

We see from the foregoing total figures that the plant made a very good showing indeed under the handicap of increased fuel and labor cost this year, but we need to get at the unit costs in order really to evaluate the situation. Slide-rule computations, or ordinary division, if necessary, soon show some interesting things. It appears that the total cost of production per kilowatt-hour rose from 6.78 to 8.96 mills in the two years, and that the fuel cost per kilowatt-hour rose from 4.78 to 7.1 mills. Here one begins to taste the fascination of statistical analysis, for it appears that the total increase in fuel cost was greater than the increase in total production cost. The explanation is that other items of expense in the station budget were less per kilowatt-hour this year than last, so that to some extent the effect of the rising price of fuel was offset by other conditions. Such a great increase in output means that the machines in the plant can turn out more electrical energy at a lower cost of labor per unit delivered at the buses, even though the total cost of labor be increased during the second period under examination. Actually there was a decrease of unit labor cost in the second year in the face of a total gain of over $6000 in the payroll.

Going farther, it appears that the coal consumption per kilowatt-hour fell from 2.1 to 1.93 lb. in the two years. This, too, was doubtless due in part to the improved load conditions. From the fundamental data given it appears that the load-factor rose from 29 per cent in the first year to 33.3 per cent in the second, a very helpful advance indeed from the standpoint of operating efficiency. It also appears that the fuel expense was 70 per cent of the total in the first year and 79 per cent in the second, and this in face of an increase in the price of coal per ton of 62 per cent. The peak load increased 28.5 per cent during the year, too.

Without going into further unit results, it may be noted in passing that a study of the percentages that the various important costs bear to each other and to the total is very well worth while, as are comparisons of the average 24-hr. loads, easily deduced from the total outputs. In the particular case analyzed, we see that an extraordinarily severe advance in the price of coal was kept within fairly close limits through operating skill and cultivation of increased loads of a desirable kind. By knowing the relations between these quantities on unit and percentage bases, the power plant executive and owner finds himself in a much better position to judge the efficiency of the service rendered than from a casual examination of the total figures, and a fine thing about it is certainly the ease with which the really significant and comprehensible quantities can be drawn into the light by a relatively small number of simple computations.

Occupations in hospital wards for disabled men, to give them a new outlook and bridge over to vocational training, is now being carefully studied and put into use by the Federal Board for Vocational Training. Among those available are drawing, typewriting, assembling small apparatus, box making, braiding, coloring and binding lantern slides, jewelry making, machine knitting, blank book making, sharpening cutlery, telegraphy, toy making.

The object is to give gentle exercise to uninjured members, arouse interest in the work and quicken the sense of ability to be useful. The activities chosen are, therefore, those that lead directly into a man's work, and must be such as produce a really useful and marketable product.

Progress is made continuously to more and more difficult occupations, not allowing a man to remain at one which he has mastered so that he can do it without effort, nor continuing so long as to produce fatigue or indifference. The object is training and preparation for future commercial occupation; but the interest is held by actually producing something, the value of which, in the most successful hospitals, has gone to a common fund for the benefit of the patients or of some outside charity.

The War Trade Board announces that all restrictions have been removed on the importation of all grades of hides, leather and manufactures of leather, including leather for belts and leather belting, also on shellac and other similar products. The question of distribution of these commodities is, however, still retained under the control of the War Industries Board.

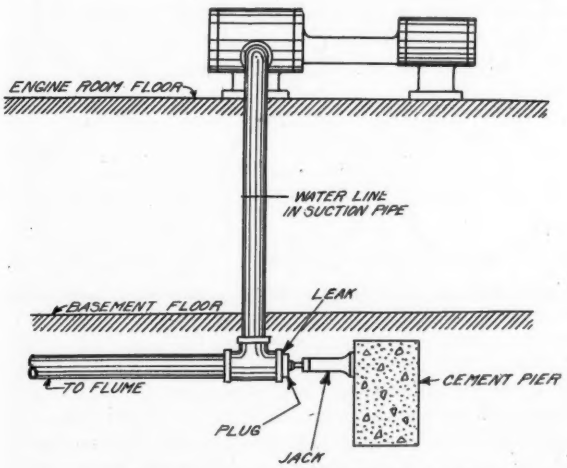
Why the Vacuum Was Poor

IN TAKING CHARGE of the steam plant in a mill having a compound condensing Corliss engine and a Buckley injector condenser, I noticed the vacuum gage registered 18 in.

In calling the assistant's attention to this, he informed me that this was all they had been able to maintain for some time.

The water was supplied to the condenser by a pump, as the lift was too great for the condenser to draft its own water.

The assistant informed me that the pump cylinder was so badly worn that it did not supply enough water to the condenser. I noticed that the pump was running very fast, but putting my hand on the tail pipe of the condenser, I found it cold. This proved that the condenser was getting enough water, so I came to the conclusion that there must be an air leak, either in the exhaust pipe or the condenser. We tested the pipe and condenser and found them tight.



LOCATION OF AIR LEAK IN PUMP SUCTION

I then began to look over the pump and suction pipe; going down to the basement where the pipe came up through the ground, I noticed there seemed to be considerable moisture around the pipe. We sent for a pick and shovel, and after digging away the loose gravel to the depth of about 18 in. we uncovered a tee with one end of it plugged.

As the pipe was a cast-iron soil pipe, the man who installed it evidently had thought it best not to trust wholly to the calked joint to hold the plug in, so he had placed a small jack screw made of a bolt and a length of 1½-in. pipe, one end of which was against the plug and the other resting on a small concrete pier he had sunk in the ground.

The bolt had rusted off and the plug had become loose, causing the pump to suck in a certain amount of air each stroke.

As the water in the flume from which the pump took its water was above the level of the tee the pump was bound to get water, although at every stroke of the pump the plug would be forced in and out and you could hear the air rushing in.

We shut the water off the flume to lower the water in the pipe, calked in the plug, made a new bolt for the jack, and when we started the pump we got 26 in. of vacuum on the condenser.

The sand and dirt that had gotten into the pump cylinder had cut it up somewhat, so we ordered a new lining. After putting it in we were able to run the pump at a much slower speed.

F. M. McCOBB.

Thin Versus Thick Belts

IN A RECENT conversation with a man whose experience entitles him to respect, the subject of belt life and endurance was broached. The individual in question has pretty definite convictions on the subject, and explained that he would not give double belting house room. He explained that unless the pulleys were of inordinate size, the internal stresses in the belt by flexure and repeated bending wore them out in a very speedy manner. His solution is increase in pulley width and decrease in thickness; indeed, he goes further, and says that even where pulley width cannot be increased it is quite as economical to use a thin belt, it will last as long. Interpolating as to belting of the Herndy type where the thickness can be anything desired, I was informed that this type of belting was ideal, but it was best not too thick.

As a practical instance of what could be done at a pinch in an emergency: A neighboring factory shut down by the main drive belt repeatedly breaking was got going again by the use of stout roller toweling purchased at the local drapers. I was invited to see the belting in use in the particular shop, and also that in the stores. It was certainly all single, and, even so, thinner than ordinary.

Although much has been written first and last on the subject of belting, the particular point elicited here does not seem to have been made prominent. Leather can be had single and double, and there are processes of tanning which plump out the substance to obtain the greatest weight from the original hide. Indeed, for years past the proverb, "there is nothing like leather," needed revision, for steady deterioration has been a uni-

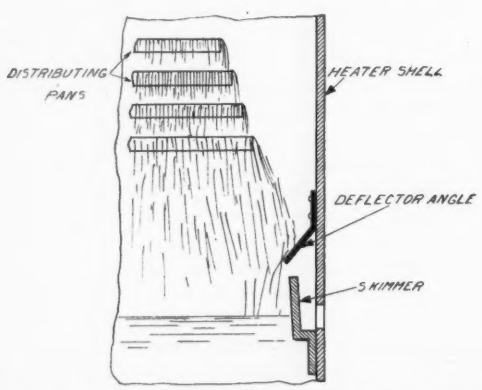
versal experience. In judging, therefore, between rival offers accompanied by small samples it needs caution, for the best color and substance is by no means the best article. The belt running over small pulleys, as in a high-speed sensitive drill, which stretches like elastic and grows thinner and thinner at each take-up is by no means uncommon, and, perhaps the conditions in this instance are the worst possible. It is equally certain that a thick belt on small pulleys has no more adhesion than the thinner type, and slippage means speedy destruction. If for unavoidable reasons the width of the pulley must be limited, and the belt thickness increased to stand the load, the pulleys must be as large as possible.

The same facts apply to Balata. This can be obtained 3, 5, 7 and 9-ply, the latter unusual but provided that the belt is narrow, there is no reason why the thickness need stop here. The limiting factor is the width canvas can be woven. My informant, whose opinions are entitled to respect, believes in thin belts of adequate width. He has given much attention to the subject first and last, and the unsuspecting belt salesman who calls for the first time is apt to be crestfallen at the result of the interview. My reason for relating the foregoing is that, from personal experience, I am inclined to think that many machine tools have stepped pulleys too narrow on the steps. Where conditions are good, it is really wonderful, the length of time that a piece of first-rate belting will endure. It reaches a dozen years in some instances, a length of time which may cause surprise in those quarters where belting costs are a disproportionate annual expense.

MARK MEREDITH.

Heater Overflow Trouble

WE RECENTLY purchased a second-hand hot water heater and after putting it into operation it worked very satisfactorily with the exception that an excessive



SCHEME EMPLOYED TO PREVENT OVERFLOW UNDER NORMAL CONDITIONS

quantity of water constantly passed to waste through the overflow connection. We tried various remedies, such as cleaning the regulating valve to see that it was not fouled and held open, adjusted the float to carry a lower water level and examined the overflow connections; but the seat of the trouble was not located. It was finally found when an interior inspection of the heater was made, for it was found that the water fell off the distributing pans in such a manner that some of it was diverted directly into the overflow skimmer, as shown in the sketch. To prevent this we took an angle iron and bolted it to the side of the heater just above the skimmer, so that the falling water was passed away from the skimmer, though the skimmer was still available for taking care of any overflow.

M. A. SALLER.

Determining Functions of Right-Angle Triangles

SHOWN in the accompanying illustration is a scheme by means of which one may readily determine the various functions of a right-angled triangle. Take, for example,

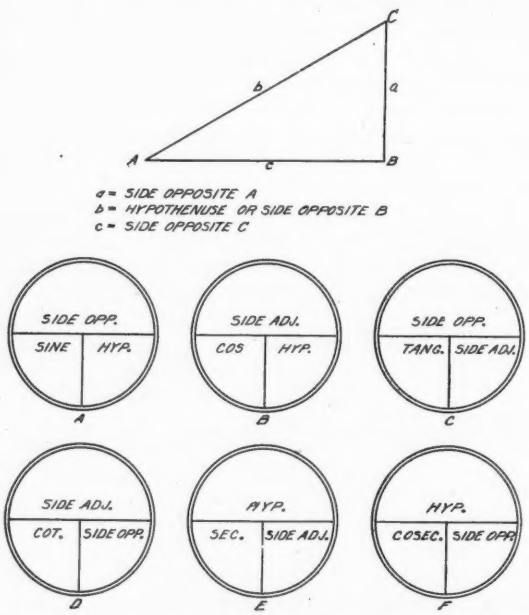


CHART FOR DETERMINATION OF TRIGONOMETRIC FUNCTIONS OF RIGHT-ANGLED TRIANGLES

circle A with the upper side designated "Side Opp." and the two quadrants "Sine" and "Hyp." Placing the finger or a pencil point on the left-hand quadrant marked "Sine," we see that this function of the angle A of the triangle shown above is equal to the "Side Opp." or side opposite divided by "Hyp." or the hypothenuse. In other words, the sine of angle A is equal to a divided by b.

Then again, let us determine how the value of the cosine may be found. Referring to diagram B, we have "Cos" (by placing the index finger or pencil point over "Cos"), equal to "Side Adj." divided by "Hyp." or c divided by b.

In a similar way the tangent, the cotangent, the secant and the cosecant may be obtained by the use of circles C, D, E and F, respectively.

DEAN B. COBB.

Acid Water From Coal Pile

ABOUT THREE months ago my water lines started to show leaks in the threads at different places and when a leak started it took only two or three days to make

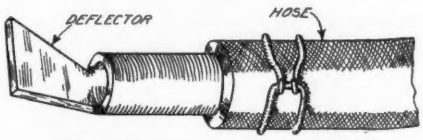
a large hole; then, when we put in new pipe it would start to leak in the threads in about a month, sometimes less, and we would have to change it again. The valve seats in our pump corroded rapidly and the valves on the lines would not hold.

Not having a chemist on the job, we secured the services of one from the steel plant, and he analyzed the water leading to our plant. He found that we were getting sulphuric acid in our pond and that it came from the steel plant, which was using water to keep a large pile of stored coal from burning up. I am anxious to learn if others have had similar experiences.

GEO. A. COWHARD.

Ash Sprinkler

THE SKETCH shown herewith illustrates an idea that one of the boys evolved for sprinkling water on the hot ashes of the pits of our mechanical stokers. It is very simple, being made from a short piece of pipe.



CONSTRUCTION OF ASH SPRINKLER

By sawing in across the diameter part way and cutting in from the end, and then flattening out the cut section, the spreader or deflector plate can be made.

File to the shape indicated and then bend inward so that all water coming out has to strike the plate and spread.

C. H. WILLEY.

Burning Hard Coal

AS I HAVE never seen anything in Power Plant Engineering about hard coal, I wish to state a few simple facts which will prove interesting.

Our city has a half-way smoke ordinance, so considerable hard coal of the buckwheat size is used. It can be burned under any boiler having sufficient grate surface. My boiler is a 250-hp. Heine, with tubes 18 ft. by 3½ in.; there are 138. I believe there are about 56 sq. ft. of grate surface divided into six sections, three front and three back, three doors and six shaking levers. For hard coal of buckwheat size, fine openings are used in grates.

In firing the run, the fire is never stirred but is kept level, and as fast as thin spots and holes show in the bed new coal is added, and as high spots show they are leveled off. If they were not, the fireman earns his money when he cleans his fire. We run 8 hr., and generally clean from 1½ hr. to 2 hr. before going home.

In cleaning, be sure to have at least 3 in. of good live hot fire. With the damper partly closed to retain heat, start at one side and push coal from front half to back half. Now dump front half of all ashes and dirt and clinkers. Pull grates level and bring all fire to clean grates, then dump back half. Be sure to have grates level, or coal will leak through. With a quick push of hoe, spread coal even over both sections and add a light sprinkle of green coal. Shut the door and let coal burn, if necessary. If you have one, use blower to get up steam. This goes for heavy load. With light load, more time can be taken, but the longer the door is open the colder the tubes and brickwork get. As soon as steam is up, proceed with next section, and do the same as with first, and be sure to have enough fire to cover clean grates, as it is easier and quicker to do so than to cover holes with green coal. As soon as door is shut, open damper wide and ash doors, and "let 'er slide." Leave ashes for the man coming on, as it is 100 per cent easier to take up ashes when you come on than it is to do this after cleaning fires, when you are short of wind and energy.

So far as I know, no stoker was ever made to make a "go" of burning buckwheat. A No. 5 scoop is best; a No. 7 too big, and a No. 3 too small. It is a big mistake and a very hard job to keep a fireman on hard coal and use stationary grates. The best grates I ever used on hard coal are the Cyclones. I am not saying this to advertise (I let the makers do that); I say it because it is the straight goods. Having a coal car makes it a lot easier on the fireman's back and disposition. Instead of hoeing out ashes, then shoveling them, why not use a long-handled shovel and save handling them twice. It is next best to a suction or any conveyor.

If anybody has anything to say in regard to burning hard coal, you know the address of Power Plant Engineering.

BOB.

Running Alternator with One Collector Ring

ON PAGE 130 of the Jan. 15 issue of Power Plant Engineering, I note an account by David Fleming as to the method he has employed to operate an alternator using but one collector ring. By doing as he states, he has grounded one side of a ring circuit and if he continues operating in this manner he will certainly ruin his bearings.

A. B. VIETH.

Diesel Engineers

A FEW DAYS ago I dropped into our laboratory and found there a copy of Power Plant Engineering of April 1, 1918. On page 301 I noticed, in an article entitled Diesel Engines, that a fellow was having trouble with a Diesel oil engine with what he termed the "butts."

Not knowing the make of engine, I cannot tell him much about it; but I have had experience with the leading makes in the United States and Europe, and I know there are some poor ones built and some very good ones. To me it appears as if the taking off of 30 hp., causing the governor to start hunting, is due to trouble in the governor springs. Evidently the wire is too light and too many turns are employed, making the springs floppy. I had a large gas engine that acted the same way. I changed the springs, substituting with one of stouter wire by 1/32 in. and cut out 4 turns in 12 in. I had no more trouble thereafter.

Loads could be thrown on and off and the governor answered at once, and that with perfect regulation at all times.

If blast or atomizing air is low and does not break up the oil so as to get perfect combustion at the proper moment, the governor will hunt. Or, if air is too high, the same effects will be had.

Cards should be taken from oil engines often, especially when changing fuel oil. I take cards once a week.

If C. W. R. will write me, I will be glad to help him out.

J. D. BOWEN.

Trouble in Main Bearing and Flywheel

ONE AFTERNOON the flywheel of my engine, which is a tandem compound jet condensing, 20 by 38 by 52 in. stroke, making 65 r.p.m. with a flywheel of 22 ft. diameter for twenty-two 1¾-in. ropes, was found shaking to such an extent that the engine was to be stopped to find out the trouble. While standing in front of the crank-shaft pedestal, it felt as if the crank-shaft was rising from the brasses with the foundation. (The engine was seated on wood blocks and not on stones.)

All the brasses, including the main bearings were examined and tightened, where they were found slack. The wedges of the main bearings, also, were tested, and as they were found loose, they were tightened; that is, nuts on the spindles of wedges were tightened. When the engine was again started the defect was much decreased, but did not totally disappear. Thinking that the main bearing wedges required further tightening, we kept it running on that day. Next morning, before starting, we tightened further, and this time, also, the nuts of the wedge spindles turned about two turns. While working during the day the shaking was getting worse, but not as much as on the first day. This clearly showed that there was something wrong which was not quite corrected. It continued to give trouble for four or five days, but we could not find out the real cause of the trouble. Wedges were tightened every now and then, and the nuts always turned whenever this was done. This caused much anxiety and worry, because it was very dangerous to run such a big flywheel in this condition.

As the screws were always giving way when tightened, it struck me that something was wrong with the screws.

One night the cap of the pedestal was removed and the upper brass, wedges and side brasses were taken out. Threads of screws were found quite filled with an oily mud, as well as the underside of the cap. After everything was cleaned out the screws were tried in the wedges and it was found that threads at the end of screws were stripped; that is, while turning the screws there was no effect in lowering the wedges. Of course that night new screws with collars could not be made, so we managed to tighten them by placing tin-sheet liners between side brasses and wedges, and making them fit for working up to the time new screws were made and replaced. From the next day the defect totally disappeared; so it proved that the flywheel was shaking, as previously mentioned, owing to the side brasses of the crank-shaft bearing being slack.

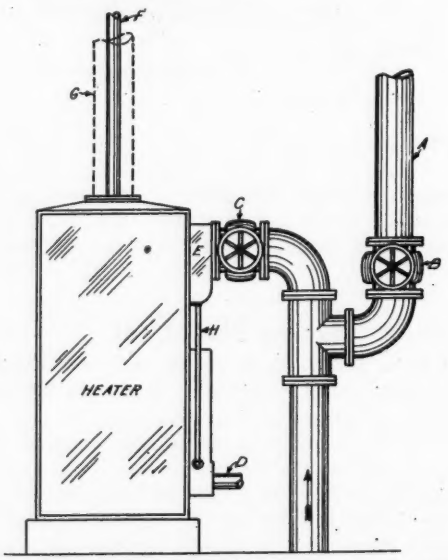
I take no pride in having solved the trouble, but write this for the readers of Power Plant Engineering to show that sometimes a slight oversight or negligence may cause such troubles. While trying to tighten the wedges, if I had taken the trouble to mark whether wedges were lowering or not, I should have found out the defect at once. I think the best thing to do in case of such a difficulty is to take out the parts where it is suspected at the first opportunity and refit them again, so that anything out of order may be seen at once and remedied as soon as possible.

N. N. BAVA ADAM.

Oil in Boilers

THE ACCOMPANYING drawing shows the piping to an open feed water heater of a well-known make, the heater being piped with a 2-in. vent pipe, F, pipe A running to the atmosphere. Valve C was left wide open, also valve B. This arrangement gave satisfaction, as some steam always showed at vent F, which was all that was necessary to keep the feed water at its maximum temperature.

Later pipe F was replaced by a 10-in. pipe, G, the idea being to pass all the exhaust steam through the heater in an effort to increase the temperature of the water. This did not help matters, as the water could only condense a certain amount of steam, and as long as steam was escaping through the vent pipe the water was as hot as it was possible to get it. When the writer took the plant he found that the boiler inspector had reported oil in the boilers, and as this type of heater had given satisfaction in other plants he could not understand how the oil got by the separator on the heater, until he found that the heater had been run with the valve B closed most of the time.



HEATER CONNECTIONS WHICH CAUSED OIL TO GET INTO BOILER

In this type of heater not more than 1½ lb. of exhaust steam per minute per square inch of exhaust inlet area should pass through the oil separator.

The exhaust inlet to the oil separator of the heater was 8-in., the area being about 50 sq. in.; $50 \times 1\frac{1}{2} \times 60 = 4500$ lb. of steam per hour. About double this amount of steam was passing through the heater a greater portion of the time, overloading the oil separator and allowing oil to pass to the boilers with the feed water.

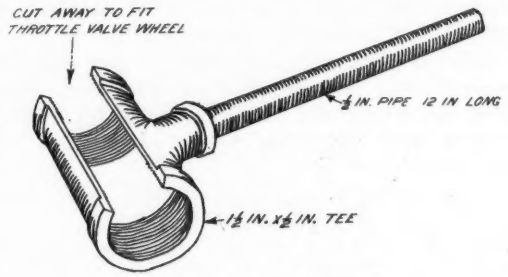
After the boilers were cleaned of oil, valves C and B were left open, with no decrease in the water temperature, and no more oil got to the boilers.

R. L. MOSSMAN.

IN ITALY an immense airplane is being built for trans-Atlantic flight with engine of 18,000 hp. A cruising plane as large is also being built in the United States for the same purpose.

An Easily Made Throttle Valve Wrench

HAVING HAD considerable trouble opening and closing the throttle valve in a particular engine, I made the wrench shown herewith. Taking a 1½ by 1½-in. tee the internal diameter of which was somewhat greater

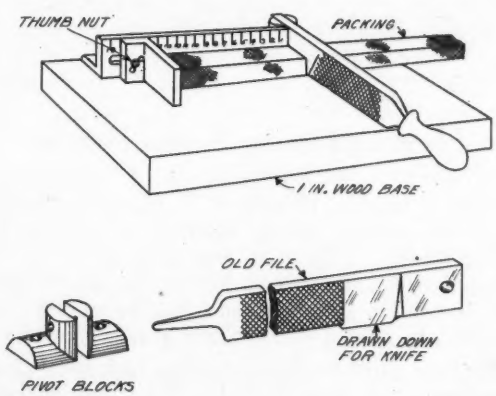


THROTTLE VALVE WRENCH

than the diameter of the valve rim, I cut out a portion of the side which would allow the slipping of this over the rim. I then took a piece of 1½-in. pipe 12 in. long, threaded one end of it and screwed it into the tee so as to form a handle. L. P. PAYNE.

Piston Rod Packing Cutter

THIS homemade device is very handy and has the advantage of being easy to make, requiring nothing but a few odd pieces of scrap and an old flat file. By a little study of the sketch the construction can be easily seen. No measurements have been given, for one can make it to suit the need. The back guide is made of a piece of 1-in. angle iron having a ¼-in. slot cut longitudinally



DETAILS AND ASSEMBLY OF PISTON ROD PACKING CUTTER

and a scale of inches marked on it for measuring the packing cut. C. H. WILLEY.

A Handy Test Lamp

THIS handy and easily-made device will be found of great value to the man about the plant in telling when he has "juice" (electricity) flowing and for locating opens and grounds, as well as to indicate when enclosed

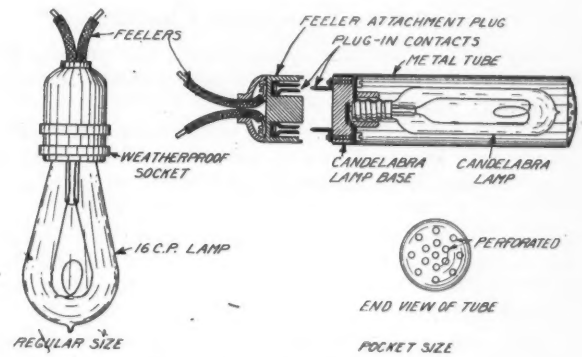


FIG. 1. A HANDY TEST LAMP

fuses are used, which one, if any, is blown. The test lamp is made from a miniature lamp base, a brass tube of the diameter of the lamp base, and the parts of an ordinary attachment plug, obtainable at any electrical

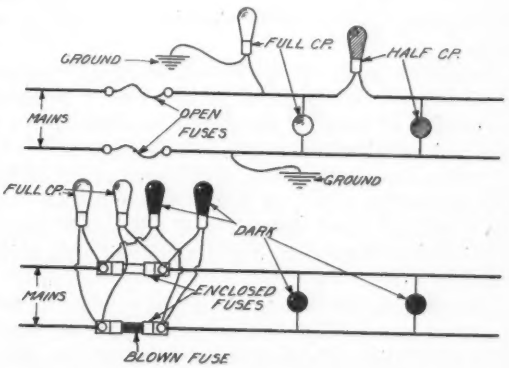
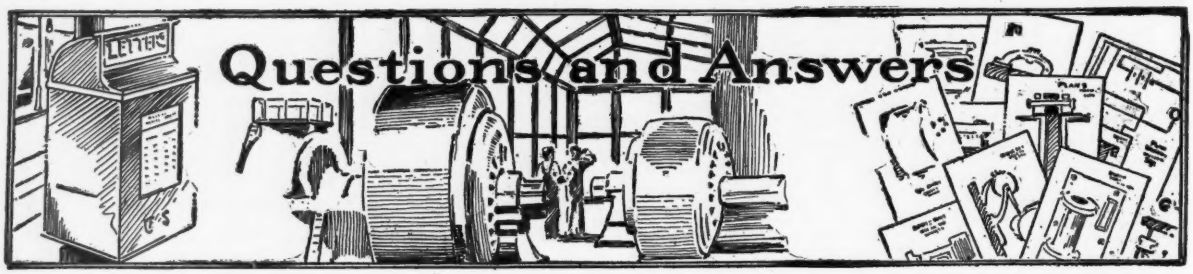


FIG. 2. METHOD OF APPLICATION

shop or easily made, with a miniature candelabra lamp of the voltage of the system upon which it is to be used. When placed across the line the lamp will light up at full candle power. When in series with another lamp or lamps in proportion to the number and size of lamps, and when one side is connected to the line and one to ground the test lamp will be dark if the other side of line is not grounded; or it will light up in accordance with resistance of line to ground. W. W. PARKER.



Using Kerosene in Boilers

WILL some of those readers of Power Plant Engineering who have used kerosene in steam boilers tell me of their experiences and results? A. B. V.

Refrigerating Equipment Questions

HOW CAN I determine approximately the quantity of ammonia required to be added to my system each year or month?

I have a 13 by 26-in. Vilter compressor and would like to know how I might keep the valves of this machine from making an unnecessarily loud noise. What causes this? J. R. Y.

A. There is no rule that states the amount of ammonia that must be charged into a system to take the place of loss. The amount put in will be equal to the amount lost through leakage and decomposition.

For real economy in operation a full charge of ammonia must be maintained. It is a mistake to imagine that money is being saved when the charging of necessary ammonia is delayed.

When the entire system is working normally the glass on the liquid receiver should be at least half full. This insures a liquid seal and so prevents non-condensed gas entering the evaporating coils.

Do not allow leakage at the rod. Even slight leakage at this point, if allowed to continue, amounts to considerable.

Inspect all parts of the system at regular intervals and whenever a leak is found fix it at once. Do not put off repairing of leaks till the end of the season. No leak is so small but that it should receive attention.

Besides the visible leaks, decomposition of the ammonia is another cause of loss. Decomposition is continually going on and the extent of this loss is governed by the amount of impurities such as oil, air and moisture allowed to enter the system.

The mechanically operated oil pump which is in use on a great many Vilter compressors must be watched closely to see that a large amount of oil is not sent into the system. The oil for the rod should pass back into the oil pan or box after it has circulated through the oil sleeve or lantern. Draw the oil from the oil separator whenever necessary.

Moisture can also be sent into the system through the oil pump.

Water dripping from the frost on the suction valves and suction line will fall into the oil pan and the pump will send it through the oil sleeve with the oil. Protect the oil pan from this dripping moisture.

To prevent air entering the system never pump a vacuum on any part of the system or on the compressor unless it is absolutely necessary. After having any part of the system open to the atmosphere pump the air out and fill the space with ammonia having a pressure above the atmosphere.

In a plant where no leakage occurs and where impurities are kept out of the system the charge of ammonia will last indefinitely without addition.

Noisy operation of the valves of a Vilter compressor is generally due to some defect of the valves. Spring tension too strong will cause the discharge valves to slam shut when the piston changes direction of travel at the end of the stroke.

Springs on the suction valves should have just enough tension to balance the weight of the valve.

Indicator diagrams will show the defects of spring action plainly.

Worn valve stems and guides will allow the valves to travel untrue and the seating surface will not strike fair. This will cause noisy valves.

Sticking valves are also noisy. This lack of free action is caused by lack of lubrication or lubrication with a poor grade of oil.

The oil in the system is, as a rule, sufficient for the lubrication of the valves. This oil travels with the ammonia and is noticeable when the compressor is opened up or when the inner surfaces of any of the pipe work are examined.

At times the valves will become dry and noisy and a small amount of oil must be allowed to enter the compressor. This oil is introduced by means of a hand pump, a sight feed lubricator or can be sent through the gas relief line from the oil sleeve of the rod.

When too much or inferior oil is used carbon will be deposited on the valves and this will cause sticking. Use nothing but a reliable brand of ammonia oil for the rod and compressor. A. G. SOLOMON.

Handling Heating System Returns

IN REPLY to an inquiry by A. J., appearing on page 133 of the Jan. 15 issue, S. E. Balcome offers some suggestions relative to the handling of returns in a heating system. I do in no way want to criticize Mr. Balcome's recommendations, but would like to offer a brief description of the system which we employ. It is what may be termed a dry return gravity system.

We have three receiving stations, each consisting of a receiver and a pump located in a pit deep enough so that the condensation drains into the receiver. The pump takes the water from the receiver and discharges it through pipes to the heater, from which it is pumped into the boilers by the boiler feed pump. We piped it first into the boiler, but had trouble in keeping the

small pump in condition to pump against 135-lb. pressure, so changed it to the heater.

We would prefer only one receiving station, but the buildings cover so much ground as to make this impossible with a gravity system.

In one or two instances we have had to make a small part of it a wet return on account of a doorway where the returns were above the floor. Originally the return pipes were buried under the floors. This made repairs so difficult that we put in a system of tunnels and ducts, so that now we can renew practically all of the return piping without tearing up any floor. On the return line at the receiver we have a 2-in. vent to the atmosphere. This is open when heating up the system, allowing the air to be driven out. It works fine, and we have had the heat on as long as six weeks continuously with no trouble with the circulation. To put in a heating system that will work one only needs to have the main and return pipes of proper size, so pitched that the water will flow by gravity to the receiver and some efficient method of removing the air. We use a globe or gate valve on the inlet and swing a check on the outlet, with an ordinary air cock on radiators or coils. The old buildings are, except the offices, equipped with wall coils of 1¼-in. pipe; the new buildings have cast-iron wall radiators, which we consider much superior to the coils. For several years we have been getting hot water radiators for use with steam. They give so much better circulation. I think A. J. would be perfectly safe in using a return trap in place of the steam pumps we use, as I think they would cost less for maintenance. J. O. BENEFIEL.

Boiler Efficiency with Oil as Fuel

IF 7222 LB. OF OIL are burned and cause to evaporate 120,245 lb. of water and the total horsepower if the boiler is 300, what is the boiler efficiency? F. S. H.

A. The data given is hardly sufficient to permit of an accurate computation of the horsepower efficiency of the boiler.

Inasmuch as the time is not given for the test, we cannot see that the horsepower of the boiler enters into the computation at all. Assuming that 120,245 lb. of water is the equivalent evaporation from and at 212 deg., each pound evaporated will take up 970.4 B.t.u. The total heat absorbed by the boiler would then be, 120,245 times 970.4 or 116,685,748 B.t.u.

Oil will give on the average about 20,000 B.t.u per pound. Multiplying this by 7222 gives 144,440,000 B.t.u furnished in the oil. Dividing the heat absorbed by the boiler, by that furnished in the oil, gives 0.8065 as the efficiency, or 80.65 per cent.

This is a high value, and depends upon two assumptions; first, that the evaporation as given is the evaporation from and at 212 deg.; second, that the heat value of the oil is 20,000 B.t.u. per pound. Either of these may be more or less incorrect, and, of course, it is possible that with an oil-fired boiler in the best of condition, you might get as high an efficiency as 80.6 per cent.

Tempering Tool Steel

I HAVE a ¾ by 2½ by 48-in. bar of tool steel which I desire to subject to a considerable bending strain and wish therefore to temper it but still not allow it to become too brittle. Kindly inform me to what temperature I should heat the bar before plunging.

SUBSCRIBER.

A. For the service to which you want to subject the bar referred to in your letter, the temperature of the bar should be at from 528 to 572 deg. F., at the time of plunging it into the water or oil. If you have a pyrometer at hand, by means of which you may be able to determine the actual temperature, so much the better; but if you have none available, the approximate temperature may be determined by noting the color of the steel which should be from dark purple to full blue.

To carry on the process, heat the bar to the required temperature, after which plunge into a pan or basin of water or oil, the pan or basin employed being of such size and shape as will allow the plunging of the entire piece at one time.

Care of Automobile Batteries

THE STORAGE BATTERY of my automobile is weak, not strong enough to turn the engine over, yet the headlights and tail lights burn dimly, showing that there is still a little life left. It is a 6-v., 80-amp.-hr. battery.

I have a voltmeter registering from 0 to 10 v., an ammeter registering from 0 to 35 amp. and an acid testing syringe (glass tube) for finding the specific gravity of the solution.

It is more experimenting than otherwise that I want to learn to charge batteries.

1. Can I charge my battery from the city current in my house, which is single phase, 60-cycle, alternating current at 110 v. or does it have to be direct current? If direct current is the proper current, how can I convert the alternating current to direct current?

2. What is the easiest way to step the current down from 110 to 6 v.?

3. What kind of acid should be used and what per cent acid to distilled water is used for the solution?

4. What should be the specific gravity of the solution used?

5. How long does it take to charge a battery and is there any danger of over-charging a battery? How can you tell when a battery is fully charged?

6. How can you tell the + from the — of a storage battery?

7. How can you tell the + from the — of the electric current in my home? Also how do you tell the + from the — on the switchboard in my engine room? I could use the current either at home or in the engine room.

ANSWERS

YOU MUST have direct-current to charge the storage battery. Alternating-current will not work. There are two ways of converting from alternating-current to direct; one is by the use of a charging outfit, which includes a mercury vapor lamp rectifier, the other is by the use of a motor dynamo set, the motor running from the alternating-current mains, and the dynamo delivering current of the voltage and capacity required.

Both of these systems involve, however, a much greater expense than would be warranted for the charging of a single starting battery. In the garages they use a rectifying set with the mercury vapor apparatus,

but there, of course, they are charging a considerable number of batteries, and can, therefore, afford the expense. The batteries are charged several in series, so that power is not wasted, as would be done when charging a single battery.

2. The easiest way to step down current from 110 v. to 6 v. is by means of a special transformer, which takes 110 v. on the primary side and gives out 6 v. on the secondary. This will not work, however, with the rectifier set, as the 6 v. is not strong enough to send current through the mercury vapor lamp. If the motor generator set is used, 110-v. a.c. motor can be used, and a 6-v. generator.

3. The solution of a storage battery is dilute sulphuric acid. For new plates this is mixed to a specific gravity of 1.25, which is a mixture of one part sulphuric acid to three parts water—the acid being the ordinary commercial acid. For old plates which are somewhat sulphated, the specific gravity of solution should be 1.15, which is made by mixing one part sulphuric acid to six parts water. This does not give quite as strong a battery as the higher gravity, but works out better with sulphated plates.

In making up the solution, the acid should be poured into the water in a glazed earthen crock, and stirred while pouring in. The mixture should then be cooled to 90 deg. F. before putting into the battery.

4. This is answered in question 3. When fully charged, the specific gravity of the solution should be 1.28.

5. The time taken to charge a battery depends entirely on the degree to which it has been exhausted, and the condition of the battery. The charge should be started at the charging rate marked on the name plate on the battery, and reduced as the charging proceeds, so that at no time does the temperature in any cell go above 100 deg. F. As soon as there is tendency to reach this temperature, the charging rate should be cut down. The charging should be continued until the specific gravity stops rising, and all cells should be gassing freely. The terminal voltage for a three-cell battery will be about 7.5, with the charging current on, when the charging is completed.

6. To determine which is the positive pole of the battery of any direct-current circuit, put the bare ends of two wires from the terminals into a glass of water. Bubbles will rise from the end of the wire connected to the negative pole. This same test will apply for your engine-room mains, but for your alternating-current mains there is no positive or negative pole; each pole is alternately positive and negative, as the current reverses.

Gear Calculations

I WOULD like to know how to determine the circular pitch of a 2½-in. pitch gear having 23 teeth.

How could I find the required diameter of a blank from which to cut a gear having 23 teeth with 2½-in. pitch? T. D.

A. In gears the diametral pitch (sometimes referred to as simply the pitch) is the ratio of the number of teeth in the gear to the diameter of the pitch circle measured in inches, or the number of teeth in the gear per inch of pitch circle diameter.

The circular pitch is the distance in inches between the centers of two adjacent teeth, measurement being along the pitch circle.

In your letter you ask us "how to find the circular pitch of 2½-in. pitch gear;" but as only circular pitch is measured in inches, it must be this you are giving. Diametral pitch is merely a ratio and therefore not expressible in inches.

If the circular pitch is equal to 2½ in. and there are 23 teeth, the pitch circle must have a circumference of 23 times 2½, or 57.5 in. Dividing this by 3.1416, we obtain a pitch circle diameter of 18.32 in.

The addendum, that is the distance between the pitch circle and the outer circle of the teeth, is equal to 0.3183 times the circular pitch (or in this case 2½) or 0.794 in. Adding twice this amount to the diameter of the pitch circle gives us 19.908 in. as the diameter of the blank from which the gear is to be cut.

Alterations Necessary with Change of Frequency

WHAT CHANGES are necessary in order to make a small 25-cycle induction motor operate on a 60-cycle circuit?

2. What is the difference between a static transformer built for use on a 25-cycle circuit and one for 60-cycle service? G. F. B.

ANSWERS

THE SYNCHRONOUS speed of an induction motor in revolutions per minute may be determined by the following formula:

$$n = 60 \times f \div p,$$

where n is the synchronous speed in revolutions per minute, f the frequency in cycles per second, and p the number of pairs of poles. Studying this formula, we find that in order to retain the original speed of the machine with an increase of frequency, it is necessary to increase the number of poles in like proportion; to do so requires rewinding the machine.

While a motor such as this may operate on a 60-cycle circuit, its speed will be excessive. This may be illustrated as follows: Assume p, or the number of pairs of poles, to be equal to 2, and f, the frequency in cycles per second, equal to 25. The synchronous speed will then be 60 times 25 divided by 2, or 750 r.p.m. Now, let us raise the frequency to 60 cycles per second, in which case the speed will be 60 times 60 divided by 2, or 1800 r.p.m.

2. Increasing the frequency of a circuit feeding a transformer increases the iron losses of the transformer, and as a consequence, in order to maintain the losses at a fixed value with an increase of frequency, the size of core will have to be increased. In other words, the core of a 60-cycle transformer is larger than that of a 25-cycle unit, thus making the first cost of the latter less than that of the former, a factor instrumental in the introduction and general use of 25-cycle current for power purposes.

A Pumping Problem

WE HAVE a driven well 200 ft. deep connected to a three plunger power pump from which we cannot get enough water. If we pipe the well up with air, can we still use our pump or will we have to pump with air into a cistern and then pump from that? E. B. S.

A. We see no reason why you cannot pump from a well with both a triplex power pump and an air lift, provided the well casing is big enough to take in both devices.

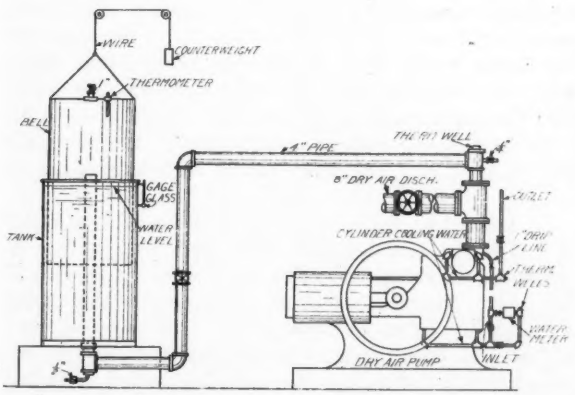
Of course, the air lift will have to be of the type which has an outside air pipe running down, and discharges air into the bottom of the lift tube. We believe, however, that, as a matter of economy, it will probably be better to use the air lift entirely for raising the water to the tank, and the three plunger pump to take it from the tank and pump it wherever it may be needed for supply.

The entire matter depends so much on the lift, the distance you have to pump and further details of installation, that it is impossible to give a final conclusion offhand.

Air Bell System of Condenser Leakage Measurement

WILL YOU kindly inform me as to the method of measurement of air leakage into steam condensers by means of the air bell system? G. S. B.

A. The accompanying sketch illustrates the method we use in measuring condenser air leakage. This shows the air bell connected to one of our condensers. Our



AIR BELL CONNECTIONS FOR MEASURING AIR DISCHARGED FROM VACUUM PUMP

arrangement at present differs from this in the following respects: We have one air bell in our station which is connected to a 4-in. header running the length of the station with connections to the discharge of each air pump with an arrangement of valves which allows us to connect the air pumps one at a time to the air bell.

The operation is as follows: The valve on the air pump discharge to the 4-in. air bell header is opened on one of the machines, after which the valve to the atmospheric discharge is closed. The air discharge from this pump then goes through the air bell, and the time which is required to raise the air bell a certain distance is taken with a stop watch from which, and the known cubic contents of the bell, the air leakage in cubic feet per minute can be readily obtained.

Our practice is to make a test for air leakage on each one of our condensers once a week, and we find this information of great benefit in maintaining a high vacuum. EDWIN B. RICKETTS,

ASSISTANT TO CHIEF OPER. ENGINEER,
THE NEW YORK EDISON CO.

The system of measurement consists essentially of discharging the air pumped from a condenser into an air bell and measuring the volume of air collected in the bell in a given time. The bell is first filled with water by exhausting all the air from it. The vacuum is then brought up to the desired point in the condenser at which the leakage is to be measured, and when this point is reached all the air is then discharged into the air bell and measurement made over any desired period of time.

Obviously an hydraulic air pump cannot be used in this test because, using water as a medium, the bell would be kept full by the water discharged from the air pump. The usual system when an hydraulic air pump is ordinarily used on the condenser is to use a reciprocating air pump to make the test.

A. B. COLE.

Series Operation of Direct-Current Generators

IS THE OPERATION of direct-current generators in series practicable?

If such machines are driven by separate prime movers such as steam engines, will not more or less trouble be encountered? READER.

A. I believe it was the early practice of the Edison Companies to generate at 110 v. and distribute three wire direct current. Some of the engine driven generators were connected to single engines and other units were made up of a single engine with a generator at each end. The operation of such a system, that is, two generators in series driven by different prime movers might be troublesome under certain conditions, particularly for short circuits or extremely heavy overloads which would give torques beyond the capacity of one of the machines but within the capacity of the other. Under this condition one of the machines would tend to be reversed in rotation and might run away in the opposite direction.

We make up motor-generator sets consisting of two generators and one motor with the generators connected in series as standard equipment for high voltage work such as 2400 and 3000 v.; but in this case the trouble mentioned above cannot occur, as generators are driven from the same source. Similarly, we connect synchronous converters in series; but they also are tied to one driving source at the alternating current end.

I believe it will be possible to operate two engine driven units in series for all ordinary operating conditions; however, special precaution should be taken if unusual conditions of overload or short circuit occur. The load on such an arrangement should be well within the maximum torque which either engine is capable of delivering. J. L. BURNHAM.

EXTENSIVE ADDITIONS and improvements, amounting to several millions of dollars, to the Westport power house of the Consolidated Gas, Electric Light & Power Co. of Baltimore, which were started some two years ago, are now nearing completion. Among the new equipment are 12 boilers of about 1000 hp. each which will furnish steam for two turbo generators. An extensive coal handling system is also one of the improvements and is arranged to serve a coal storage space of 50,000 T. capacity.

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How Much Insulation?

Covering of piping, heaters, engine cylinders and other steam-carrying vessels to reduce heat radiation has long been recognized as desirable and economical. Just how far to go in investment has been, however, a question to which no definite answer has been given until now. Experience has shown that for high pressures and temperatures the covering known as 85 per cent magnesia has given, on the whole, most satisfactory results, and it may be considered standard practice for such work.

Data given by Glen D. Bagley, of the Mellon Institute, are, therefore, of great importance in establishing a standard as to the amount of insulation that can be used with economy.

As an indication of the loss caused by bare pipe, it is stated that 1000 sq. ft. of surface carrying steam at 100 lb. pressure will waste 300 T. of coal a year. The saving of most of this can be accomplished by insulation, and the effort of Mr. Bagley was to determine how much it pays to save, considering the cost of the fuel, and the investment in insulation.

A common figure for radiation loss is 3 B.t.u. per sq. ft. per hr. per degree F. of temperature difference between the bare iron surface and surrounding air, but experiments prove that this is not even a good average, since Paulding's curves show that for ½-in. pipe the loss varies from 3 B.t.u. at 100 deg. temperature difference to 6 B.t.u. at 500 deg. difference; and for 16-in. pipe the variation is from 1.8 B.t.u. at 100 deg. to 4.5 B.t.u. at 500 deg. difference. Evidently, therefore, the size of pipe and the temperature difference must be considered for any logical solution of the problem.

It seemed probable, also, that there would be a like variation for the radiation loss from the surface of insulating covering, so experiments were made with 85 per cent magnesia coverings to determine this point. As it was out of the question to test all sizes of covering, a 3-in. pipe was taken as an average size, and it was found that for bare pipe the radiation varied from 2.15 B.t.u. per sq. ft. per hr. per degree difference at 100 deg. difference, to 5.15 B.t.u. at 500 deg. difference. For covering, the variation was as follows:

	Temp. Difference 100 deg.	Temp. Difference 500 deg.
1 in. thick	0.42 B.t.u.	0.56 B.t.u.
2 in. thick	0.30 B.t.u.	0.39 B.t.u.
3 in. thick	0.26 B.t.u.	0.31 B.t.u.

Also the effect of convection was indicated by a test in which a breeze of 30 mi. per hr. was blown over the pipe from a fan, which increased the radiation 40 per cent.

Tests of covering that had been in service showed that time does not affect the efficiency of the covering, but soaking in oil does reduce the efficiency materially. Having these figures, certain assumptions were necessary as to cost of insulation, installed, cost of fuel and operating period. A consideration of available data led to the assumption that application of the covering would cost 20 per cent of the list price of material. That annual charges should be 6 per cent for interest, 5 per cent for depreciation, 2 per cent for insurance and mis-

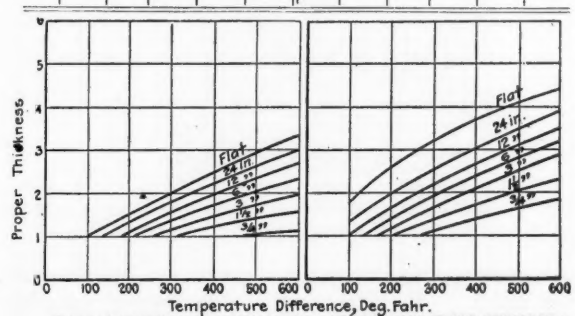
cellaneous expense; or a total annual investment charge of 13 per cent of the total cost for material and application.

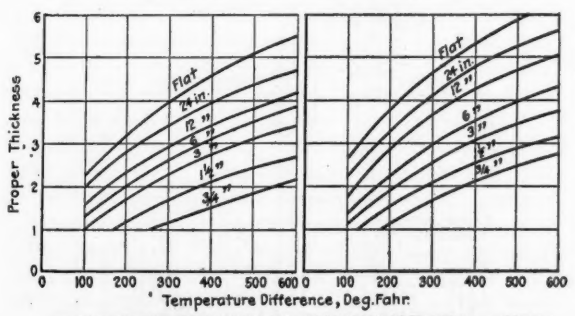
On the fuel side, it was assumed that 1 lb. of coal evaporated 7 lb. of water from and at 212 deg. under average conditions; that a pound of steam would carry 1000 B.t.u. above that in the feed water. And the annual operating cost would be the annual investment charges plus the annual fuel cost for heat lost by radiation.

THICKNESS OF 85 PER CENT MAGNESIA FOR MAXIMUM NET SAVING

Thickness in Inches. S = Standard Thickness

Size Pipe, Inches	Hot Water, 175° F.	Steam, 5 Lb.	Steam, 100-200 Lb.	200 Lb. 150° F. Superheat	200 Lb. 300° F. Superheat.
Coal at $2 per Ton					
¼	S	S	S	S	S
1½	S	S	S	S	2
3	S	S	S	1½	2
6	S	S	1½	2	2
12	S	S	2	2	3
24	S	S	2	3	3
Flat	1	1½	2	3	3½
Coal at $4 per Ton					
¼	S	S	S	1½	2
1½	S	S	1½	2	2
3	S	S	2	2	3
6	S	S	2	3	3
12	S	S	3	3	4
24	S	S	3	4	4
Flat	2	2	3	4	4½
Coal at $6 per Ton					
¼	S	S	1½	2	2
1½	S	S	1½	2	3
3	S	1½	2	3	3
6	S	2	2	3	4
12	1½	2	3	4	4
24	2	3	3	4	5
Flat	2½	3	4	5	5½
Coal at $8 per Ton					
¼	S	1½	1½	2	3
1½	S	1½	2	3	3
3	1½	2	3	3	4
6	1½	2	3	4	4
12	2	3	3	4	5
24	2	3	4	5	6
Flat	2½	3½	4½	5½	6½





Based on these assumptions, calculations were made for seven sizes of pipe, for five temperature differences and four different fuel costs, and the minimum operating cost determined for each set of conditions. As an additional convenience, the calculation was also made for four sets of known costs per million B.t.u., which eliminates assumptions as to fuel values and evaporative efficiency where exact records of the cost of steam are available.

The tables and curves resulting were shown in large form in the Power Plant Engineering Data Sheets in the issue of Sept. 15, 1918, and are reproduced here for reference.

It is evident that for ordinary steam pressures, and on piping up to 3-in. the standard thickness of covering, about 1 in., is the most economical; while for larger sizes of piping, and for high pressure or superheated steam, the extra cost of additional thickness will prove a good investment.

As fuel cost increases, the advisability of extra insulation becomes greater, and it is quite evident that the subject is one of real engineering importance, not to be treated in the off-hand fashion as has commonly been done heretofore.

It is to be remembered that these data are only for 85 per cent magnesia covering, and it is likely that for small pipe and low temperatures a less expensive covering may prove most economical, but as fuel costs are continually rising, it is also likely that during the life of the covering the larger investment might be warranted, as the table for coal at $8 a ton shows that for all but two sets of conditions extra thickness of insulation of even 85 per cent magnesia is warranted.

Certainly, when so large a proportion of the conditions warrants the use of extra thickness of covering, there can be no question about the economy of covering all pipes with some form of insulation.

And it should be noted that where there is extra exposure to low temperatures or to wind, the most economical thickness would be greater than shown, because of the added heat loss from convection.

Redeeming America's Promise

Before this war, Europeans thought that America was a nation which idolized the dollar.

Chateau Thierry taught them that Americans would die for principles. St. Mihiel showed that Americans could think and act in a big way. The French have kept on paying after the armistice. Are you going to quit?

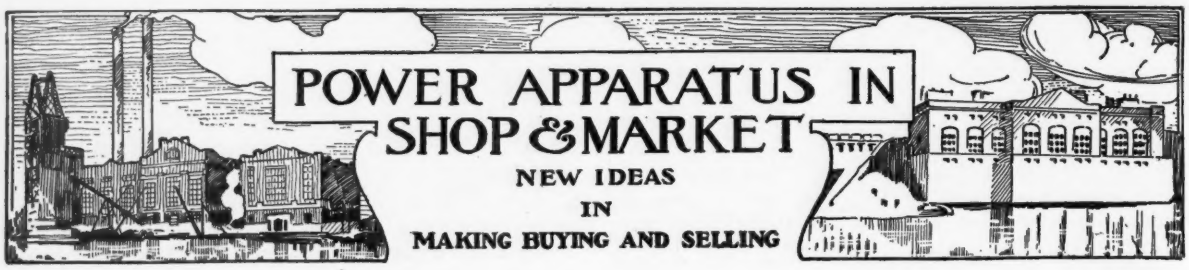
Our liberal outpourings of blood and treasure on the battlefields must not be degraded now. We must pay our war bills promptly. We have "fought the good fight," but have we "finished the course"?

We have paid the cost in blood, but the Fifth Liberty Loan is coming. It must be a triumphant success or the world's high opinion of us will be falsified.

It is plain nonsense to say that you cannot save part of your pay to invest in Fifth Liberty Bonds. Just suppose your pay was less than it is by $10 or $5 or $2. Take it out when you get your pay—and the thing is done. You'll live on the rest, the same as if your pay were really less. Only you'll have your bond to show for the effort after you get through. That is the safe and sensible way to do it. You can if you will.

The American nation is on trial. We must redeem ourselves, and that means each one of us. Anything short of full success of the Fifth Liberty Loan will disgrace America in the eyes of our Allies. They will have the right to say, "The Yankees hate to pay."

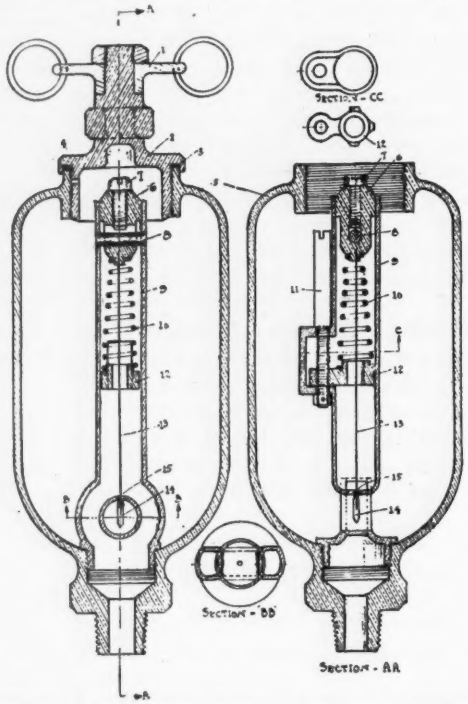
Buy to the utmost of your ability.



The Johnson Graphite Lubricator

A GRAPHITE LUBRICATOR particularly adapted for use in connection with steam engines and pumps, air compressors and gas and Diesel engines is the one shown herewith and manufactured by the Johnson Graphite Corporation, New York City.

As the steam is turned on, pressure is established within the lubricator equal to that of the line. At the end of each engine stroke, however, a slight drop of line pressure is experienced which, being communicated to piston 6 through the medium of casing 9, causes (on account of the greater pressure within the body of the



SECTIONAL VIEWS OF THE JOHNSON GRAPHITE LUBRICATOR

lubricator) this piston to have a slight downward travel. This in turn moves wedge-shaped needle 14, which opens small hole 15 and allows a small amount of graphite to be forced into the main steam line.

When no more steam is taken by the engine or pump, the pressure on the main line is re-established and piston 6 forced upward, thereby closing feed hole 15. Spring 10 assists piston 6 on its return stroke, and when more than one engine or pump is in operation and supplied from the same line, this spring prevents movement of piston 6, except when the engine to which it is connected takes steam.

Spring 10 should be adjusted when lubricator is installed; this may be done by screwing either up or down, regulating screw 11.

Automatic Compensation for Starting Squirrel-Cage Induction Motors

AMONG recent developments in the electrical field is an automatic compensator which is the product of the Electric Controller Mfg. Co. It is used to start squirrel-cage induction motors by first applying

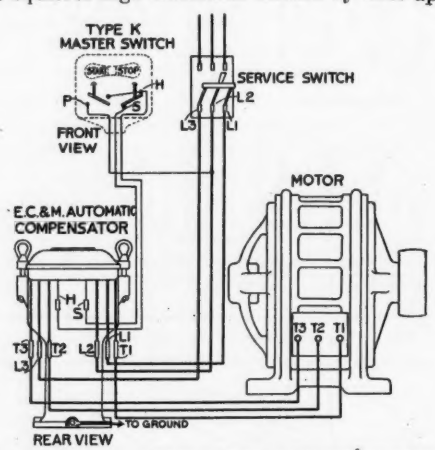


FIG. 1. AUTOMATIC COMPENSATOR CONNECTION WITH NO VOLTAGE PROTECTION ON A 3-PHASE MOTOR

a reduced voltage to the motor and finally connecting the motor to the line when it has reached the right speed. The transformer which furnishes the low volt-

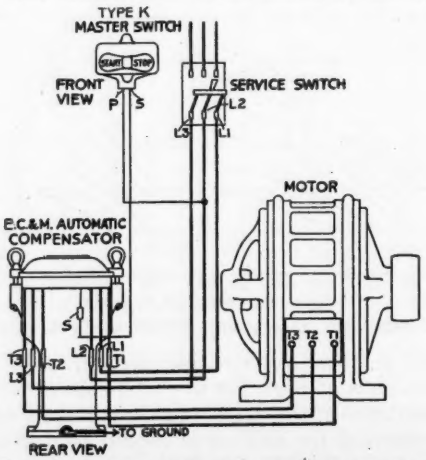


FIG. 2. CONNECTIONS FOR NO VOLTAGE RELEASE FOR 3-PHASE MOTOR

age for starting has four sets of voltage taps, to give 40, 58, 70 and 85 per cent of line voltage. Any of these voltages can be used, but the lowest one that will start the motor quickly enough should be selected, since the use of a starting voltage higher than necessary will make the starting current unnecessarily large. When the "start" side of the master switch is pressed, the compensator automatically starts the motor; when the "stop" side is pushed, the motor stops.

With the no-voltage protection arrangement, if the voltage fails while the compensator is in the "start" or "run" position, it will immediately fall to the "off" position. When the voltage returns, the compensator will remain in the off position until the "start" button of the master switch is pushed. Figure 1 shows the connections of the compensator arranged to provide no-voltage protection for a three-phase motor.

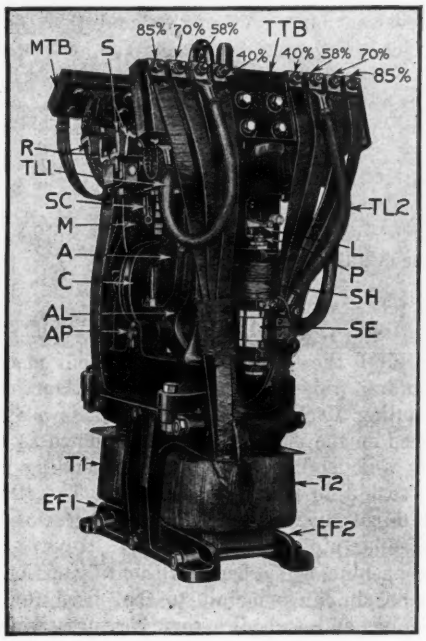


FIG. 3. COMPENSATOR REMOVED FROM CASING, SHOWING TRANSFORMER LEADS AND TRANSITION RELAY

The compensator can be controlled from a float switch or pressure regulator, in which case the compensator arranged for no-voltage release is used. With the arrangement shown in Fig. 2, when the voltage fails, or the control switch opens, the compensator falls to the "off" position and stops the motor, but when the voltage returns, or the control switch closes, the compensator automatically starts the motor again.

Figures 3 and 4 are views of the compensator removed from the case, both showing the machine in the "off" position. T_1 and T_2 are the coils of the transformer, which is clamped between the transformer end-frames, EF_1 and EF_2, forming the base of the compensator. Eight insulated leads pass from the transformer to the transformer terminal board TTB. TL_1 and TL_2 are two flexible tap leads which may be connected to different voltage taps for selecting the proper starting voltage. M is a U-shaped operating magnet carrying the operating coil C on its lower pole, and a shading coil SC on its upper pole to prevent chattering. The armature lever AL carries the armature A, and is pivoted on the pin AP. S indicates the starting main contacts and R the running main contacts. In Fig. 3, SH is the shunt coil and SE the series coil of the transition relay, which allows the compensator to move from the "start" to the "run" position. When the "start" side of the master switch is pushed the operating magnet is excited, closing the armature, moving the starting contacts into engagement and thereby connecting the transformer to the line, the motor to the transformer, and exciting the two coils of the transition relay. At the same time the spring SP is compressed through the link X and the bell-crank Y, Fig. 4.

The compression spring is thrusting on a toggle to move the contacts from the "start" to the "run" position, but the latch prevents the toggle from straightening out. When the motor current has dropped to the right amount the transition relay plunger rises, striking the latch and releasing the toggle. The compression spring immediately forces the contacts to leave engagement on the starting side and make engagement on the running side.

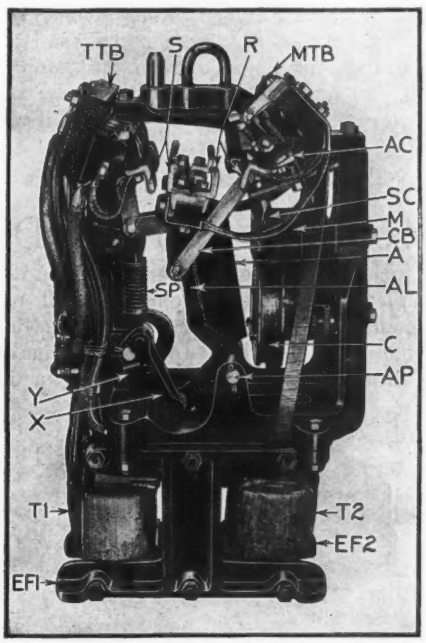


FIG. 4. SHOWING WORKING PARTS OF COMPENSATOR

When the "stop" side of the master switch is pushed, the operating magnet is de-energized and the compensator falls to the "off" position, disconnecting the motor from the line and allowing it to stop. At the same time the latch re-engages so that it is set for the next start.

Auxiliary contacts are provided in the compensator for three-phase motors for disconnecting the middle lead of the motor from the line, so that when the compensator is in the "off" position all connections to the motor are open. The auxiliary contacts are operated by the armature lever by means of a connecting bar.

The control circuit contact is operated by the connecting bar and completes the holding circuit for the

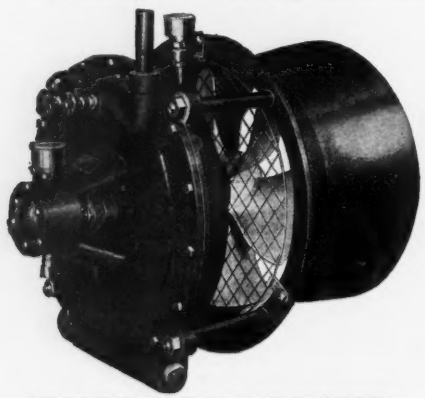
operating coil when the compensator is arranged for no-voltage protection.

The master switch used with compensators arranged for no-voltage protection comprises two double-blade snap switches, one of which is normally open and is momentarily closed to start the motor, while the other is normally closed and momentarily opened to start the motor. When the start switch is closed by pushing the "start" button, the compensator operating coil is excited, causing the armature to close. The armature in operating closes a control circuit contact inside the compensator, which completes a holding circuit for the operating coil, so that it remains excited, although the "start" button is released immediately. To stop the motor, the "stop" button is pushed, which opens the circuit through the operating coil, whereupon the compensator goes to the "off" position and disconnects the motor from the line.

The master switch used with compensators arranged for no-voltage release comprises one double-blade snap switch, which remains closed when the "start" button is pressed, and remains open when the "stop" button is pressed. It can be used in series with a float switch or pressure regulator for independently controlling the operation of the compensator when the float switch or pressure regulator is closed.

Turbo Blowers for Forced Draft

THE turbo blower shown here is designed as a unit, complete and ready to operate. All parts are standardized making them interchangeable. The turbine rotor is supported by two bearings, thus eliminating the disadvantage of overhung construction; the



TURBO BLOWER READY FOR SHIPMENT

bearings are so placed that there is no possibility for misalinement of the shaft. A removable sleeve is provided for holding each bearing; the rings can be replaced when worn at a slight expense. The turbine casing which is cast in one piece, is constructed with a safety ring in combination with the turbine cover, preventing damage by excessive rotor speed. The turbine cover contains the steam chamber, nozzle ports and controlling valves, which gives easy access.

A removable plug is placed opposite each nozzle for inspection. The exhaust steam may be diverted from the ash pit and piped to a feed water heater if desired. The turbine is designed so that a back pressure of 15 lb. may be safely carried.

The fan casing is designed on the Venturi principle which allows an easy flow of air giving high efficiency and almost noiseless operation. With each blower is furnished a specially designed steam strainer to prevent scale and other foreign matter from getting into and plugging the nozzles, also full installation and operating instructions. The blower can be used with furnaces of all descriptions, principally boiler furnaces; and make possible the burning of lower and less expensive grades of fuels.

Automatic control of this turbo blower by the steam pressure from the boiler is obtained by means of a regulator valve or damper regulator connected to a balance valve in the steam line to the blower, also one or more blowers may be controlled by one valve which maintains at all times a uniform steam pressure in the boiler or boilers. Increased boiler capacity from 100 to 200 per cent is made possible by the strong draft produced.

The coal is burned effectively and thoroughly and the periods of cleaning are less frequent than with ordinary natural draft; in addition, clinkers are practically prevented as the discharge of exhaust steam from the turbine with the air into the ash pit breaks up their formation.

The illustration is reproduced from a photograph of the blower ready for shipment.

The blower range in sizes from 1090 to 19,600 cu. ft. of air per minute.

For Bending Large Pipes

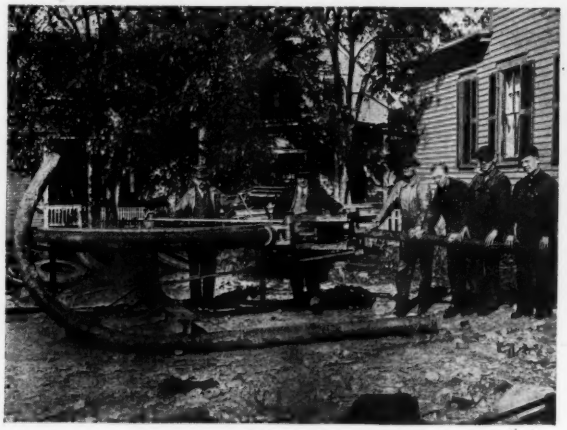
TO MEET the demand for an efficient machine for bending pipe of large sizes, the American Pipe Bending Machine Co., Boston, Mass., has patented and placed on the market a machine known as Hercules Model C, and having a capacity for bending pipe and tubing from 3 to 8 in. in diameter. The illustration shows a 6-in. standard iron pipe in process of bending, with a similar pipe already bent.

This machine, which bends without distortion of area, is built on similar principle to that used for bending smaller pipe and embodies some features which differ from the other nine models built by this company. Each of the different sizes of pipe has a former-segment which fits the outside, and a swinging arm carrying the bending unit. A shoe is swiveled on a bell crank, journaled in the carriage attached to the swinging arm, the carriage being adjustable radially on the arm to and from the center of the segment; the shoes are inter-changeable for different sizes of pipe. Acting on the other end of the bell crank is a powerful toggle-joint in which is mounted a roller engaged by a cam lever, also journaled on the carriage, and having a stem on which may be slipped a 4-in. pipe of such length as may be required to obtain necessary leverage.

In forming the pipe, the length is held by a yoke or clamp at one end of the segment, and the swinging arm with its mechanism is rotated until the shoe engages the surface of the pipe, the toggle being withdrawn. The cam at its lowest portion engages the roller, and pressure is applied by a sufficient number of men to rotate the cam through a half circle. By this motion the toggle is straightened and the bell crank carrying the shoe is

rotated on its journal, the shoe and former gripping the pipe, and thus preventing distortion.

This process is repeated in a step by step way until the bend is complete. The machine is well built, rigid, and simple. The segments are loosely supported on a central head, and are readily changed. It is portable, and is so assembled that it may be knocked down and set up in a few minutes. It is arranged to bend all pipe cold without filling, to a radius of from five to eight times the pipe diameter; this radius may be materially reduced by hot bending. Although a standard radius of former-segments is used, bends of greater radius may be made with the same segments, a minimum radius being used and varying with the different sizes of pipe.



THE HERCULES MODEL C PIPE BENDING MACHINE

The bend shown was made by nine men in a little over 9 min. of time.

A Modern Coal-Handling Equipment

DURING 1917 the Fairfield Glass Co., Lancaster, Ohio, installed what has proven to be a very efficient coal crushing and elevating equipment in connection with their new glass house gas producer plant. The entire producer plant with the exception of the two wood producers having been designed, manufactured and erected by a prominent manufacturing company of Ohio.

The coal received at the plant drops from the cars into a 12-ft. square receiving track hopper, the rails over this hopper being carried by heavy steel girders supported from concrete walls. The hopper plates are sloped sufficiently to give a self-cleaning action.

A reciprocating plate feeder takes the coal from the hopper at a uniform rate of 25 tons per hour, delivering it to the foot end of an inclined apron conveyor shown in Fig. 1. This apron is made of two strands of malleable iron roller chain and 30-in. long double beaded flights. Note the upright angles termed lifting blades, the use of which allows a steeper angle for the apron and therefore less distance between the track and producer house.

A 24 by 24-in. single roll coal crusher is located below the head end of the apron and reduces the coal to the desired size for the producer. A 25-hp. motor is belt connected to the countershaft of the crusher and the apron and feeder are driven from the roll shaft of the crusher. Wood shearing pins are inserted in the arms of the crushed fly drive wheel pulley, and should any foreign object such as a coal pick or coupling link enter the machine, the pins are at once sheared and the drive automatically disconnected. The feed arrangement also automatically stops.

The crushed coal flows by gravity from the crusher

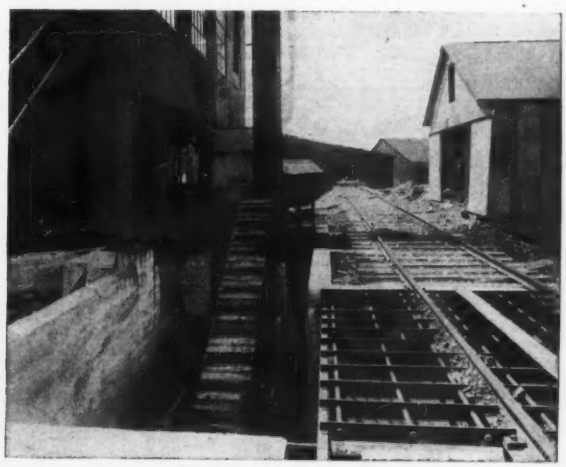


FIG. 1. CONVEYOR FOR DELIVERY OF COAL TO CRUSHER

to the foot of a vertical elevator, 67 ft. high. The buckets, which are 14 by 7 in. and of malleable iron, are mounted every 2 ft. on a single strand chain traveling at a speed of 200 ft. per minute.

All parts of the elevator are encased, a platform with hand rail being built around the head end. This supports the 7¼-hp. motor direct connected to the elevator countershaft.

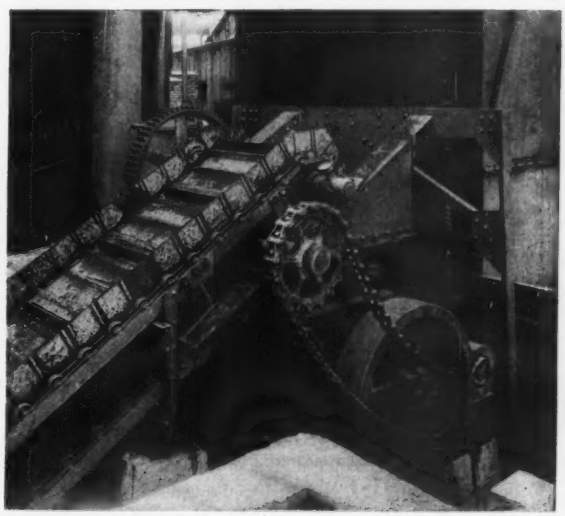


FIG. 2. VIEW OF CRUSHER PLACED BELOW HEAD END OF APRON

Twelve-inch diameter steel plate chutes lead the coal from the elevator to the two 50-ton enclosed bunkers over the gas producers.

Great care was exercised in the design to obtain safety for the operators of the machinery and ample space was provided to give easy access to all parts.

Convenient Telescopic Hoist

AN EASY way of removing ashes from basement to sidewalk, or, when hatchway is located near sidewalk or curb, in private alley, directly into a wagon, is made possible by a telescopic hoist.

The apparatus consists of a sturdily constructed hoist, which telescopes below, and is invisible from the grade when not in use. A telescoping handle is attached to the hoist in such a way that a few turns raise the hoisting head to its proper position over the hatchway and at the same time raise the sidewalk doors and bring spring guard gates into position to protect pedestrians.

The operator, after raising the hoist in position, climbs to the sidewalk and hooks the ash cans from the sidewalk by using the ash cans adapted for this purpose.

The apparatus is built in various models for hand

FIG. 1. HOIST SHOWING ONE MAN REMOVING ASHES FROM BASEMENT

or power operation and to meet conditions at the building and the quantity of ashes to be handled; other models are furnished to suit unusual conditions. The hoist can be readily installed in old buildings as well as new ones, thereby making it possible to use the hoist wherever ashes must be raised to the sidewalk from the basement.

Figure 1 shows one man removing ashes from boiler room to grade. Figure 2 shows hoist operator hooking up cans from sidewalk position.

Baffles and Draft

IN the setting of boilers, one of the most important points is proper arrangement and tightness of baffles. Theoretically the gas passages should diminish gradually in area from fire box to breeching in proportion as cooling of the gases decreases their volume. This is difficult to accomplish with the ordinary form of iron flame plates, and fire brick wall construction, but can be secured with inclined baffles built of plastic material and tile. The tapered gas pass secured with the baffle inclined forward from the top of the bridge wall has, also, the advantage of aiding to keep all parts of the gas passages full of hot moving gas, thus avoiding dead corners.

For old boilers, the plastic construction has the added advantage that it can be moulded tight around bent tubes, thus giving a tight baffle when rebuilding, even if the baffle be built upon the original flame plates. To replace a tube, the hole in the baffle can be somewhat enlarged, and, after the new tube is in place, the hole is filled with plastic material again. This construction is, therefore, of essential aid in preventing leakage through baffles, which is a cause of considerable loss.

The harm from leaky baffles is twofold; they permit hot gases to pass direct from firebox to stack without giving up their heat to the boiler; also they permit a high draft in the firebox which draws in excess air, lowering the temperature of the gases, and interfering with regulation of the combustion rate.

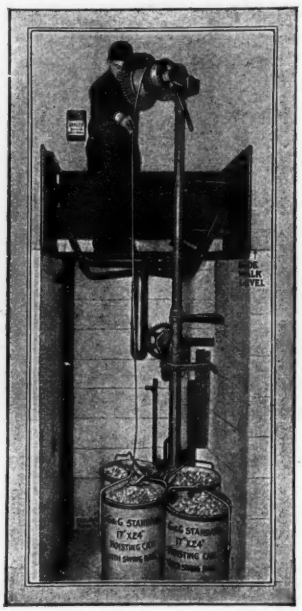


FIG. 2. HOIST OPERATOR HOOKING ASH CANS FROM SIDEWALK ELEVATION

To maintain ideal conditions, just sufficient air should be forced through the fire to produce the desired rate of combustion, and just sufficient suction maintained above the fire to carry away the gases as rapidly as they are formed.

With forced draft the amount of air supplied to the fuel bed, which determines the rate of combustion, is usually controlled by a regulator, changing the speed of the forced draft fans in accordance with the rise and fall of the steam pressure in the header. With forced draft the suction above the fire should be only sufficient to remove the gases due to combustion and should remain constant for all rates of combustion. This is best done by damper regulation on each boiler, controlled by the suction above the fire.

With natural draft, the suction in the furnace chamber is used not only to remove the waste products of combustion, but to furnish motive power to supply the amount of air needed for the combustion. This means that heavier suction is required in the furnace chamber than when forced draft is used. This suction may become excessive at high ratings and in fact may reach

These tables contain data especially worked out or carefully selected that are vital to your work. You may need them at any time and should preserve them. A handy, serviceable, loose-leaf cover in which these tables fit exactly, will be sent you for 30 cents in currency or stamps

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POWER PLANT ENGINEERING

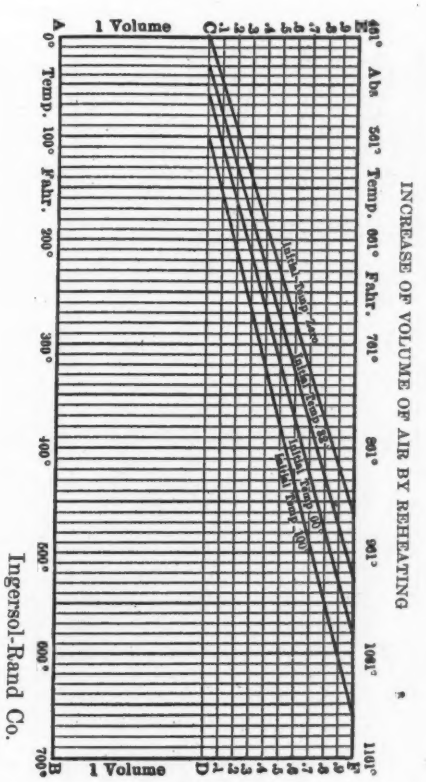
COMPARISON OF STRENGTH BETWEEN WIRE ROPE AND MANILA ROPE

Approximate Breaking Stress Calculated in Tons of 2,000 Pounds

Diameter in Inches	Wire Transmission Rope. One hemp core surrounded by six strands of seven wires each				Wire Hoisting Rope. One hemp core surrounded by six strands of nineteen wires each				Average Quality New Manila Rope
	Iron	Crucible Cast Steel	Extra Str'g Crucible Cast Steel	Plow Steel	Iron	Crucible Cast Steel	Extra Str'g Crucible Cast Steel	Plow Steel	
	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons	Tons
2¾	. . .	. . .	. . .	. . .	111	211	243	275	26
2½	. . .	. . .	. . .	. . .	92	170	200	229	21½
2¼	. . .	. . .	. . .	. . .	72	133	160	186	18½
2	. . .	. . .	. . .	. . .	55	106	123	140	15
1¾	. . .	. . .	. . .	. . .	44	85	99	112	12½
1⅝	. . .	. . .	. . .	. . .	38	72	83	94	10
1½	32	63	73	82	33	64	73	82	8½
1⅜	28	53	63	72	28	56	64	72	7½
1¼	23	46	54	60	22.8	47	53	58	6¼
1⅛	19	37	43	47	18.6	38	43	47	5¼
1	15	31	35	38	14.5	30	34	38	4
⅞	12	24	28	31	11.8	23	26	29	3¼
¾	8.8	18.6	21	23	8.5	17.5	20.2	23	2¼
⅝	6	13	14.5	16	6	12.5	14	15.5	2
9/16	4.8	10	11	12	4.7	10	11.2	12.3	1½
½	3.7	7.7	8.85	10	3.9	8.4	9.2	10	1 1/8
7/16	2.6	5.5	6.25	7	2.9	6.5	7.25	8	¾
⅜	2.2	4.6	5.25	5.9	2.4	4.8	5.30	5.75	½
5/16	1.7	3.5	3.95	4.4	1.5	3.1	3.50	3.8	⅜
9/32	1.2	2.5	2.95	3.4	. . .	. . .	. . .	. . .	3/10
¼	. . .	. . .	. . .	. . .	1.1	2.2	2.43	2.65	¼

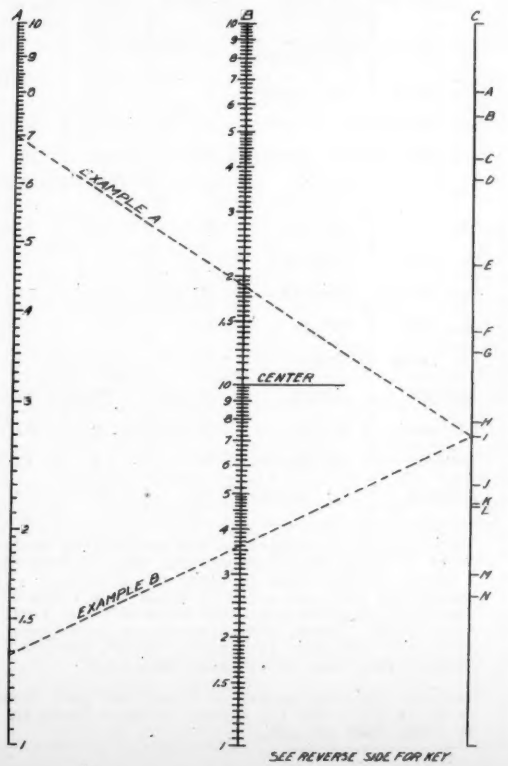
Waterbury Co.

POWER PLANT ENGINEERING



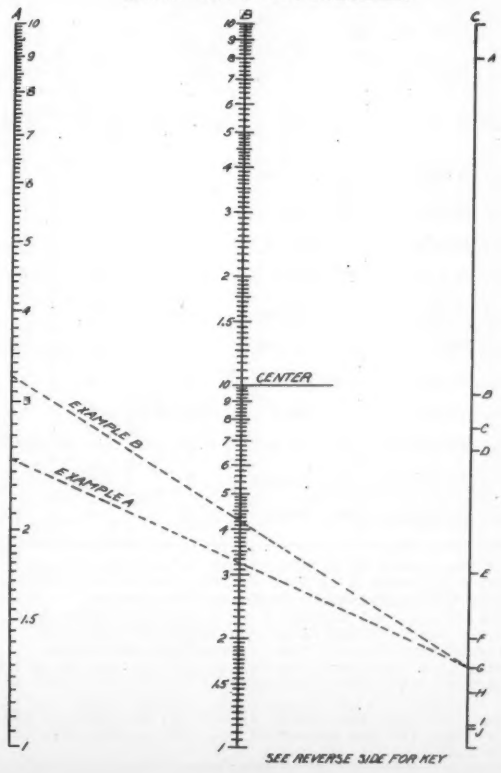
POWER PLANT ENGINEERING

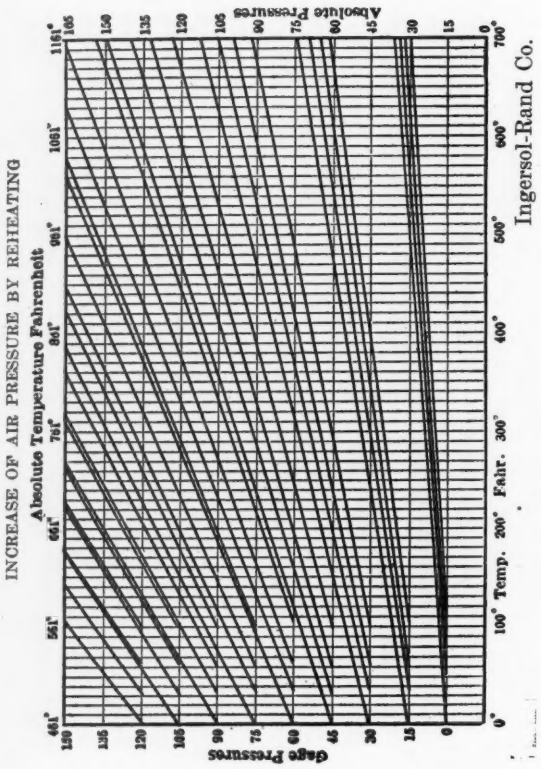
CONVERSION CHART FOR VOLUMES



POWER PLANT ENGINEERING

CONVERSION CHART FOR AREAS





KEY TO CONVERSION CHART FOR AREAS

Scale A	Scale B	Scale C	To Locate Decimal* Below Center	To Locate Decimal* Above Center
Sq. Meters	Sq. Inches	E	+3	+4
Sq. Meters	Sq. Feet	I	+1	+2
Sq. Meters	Sq. Yards	H	0	+1
Sq. Yards	Sq. Feet	A	0	+1
Sq. Yards	Sq. Inches	G	+3	+4
Sq. Feet	Sq. Inches	F	+2	+3
Sq. Miles	Sq. Meters	D	+6	+7
Sq. Miles	Sq. Feet	C	+7	+8
Sq. Miles	Sq. Yards	B	+6	+7
Sq. Centimeter	Sq. Inches	E	−1	0
Sq. Centimeter	Sq. Feet	J	−3	−2

*The number of digits to the left of the decimal point in scale B is more or less than that in scale A by the amount shown in these two columns. The scales are read similarly to those on a slide rule, i.e., the numbered divisions represent the first significant figure, the intermediate unnumbered divisions represent the second figure, and the third figure must be interpolated.

Examples: (A) The number of sq. in. in 2.50 sq. yds. is 3240. (B) The number of sq. yds. in 4212 sq. in. is 3.25.

SHEAVE AND DRUM TABLES

Showing Relative Effects of Various Sized Sheaves or Drums on the Life of Wire Rope.

Cast Steel Ropes for Inclines

6 Strands of 7 Wires Each—Hemp Center

Diam. of Rope in Inches	Diameter of Sheaves or Drums in Feet. Showing Percentages of Life for Various Diameters 100%	90%	80%	75%	60%	50%	25%
1½	16	14	12	11	9	7	4.75
1⅝	14	12	10	8.5	7	6	4.5
1¾	12	10	8	7.25	6	5.5	4.25
1⅞	10	8.5	7.75	7	6	5	4
1	8.5	7.75	6.75	6	5	4.5	3.75
⅛	7.75	7	6.25	5.75	4.5	3.75	3.2
¼	7	6.25	5.5	5	4.25	3.5	2.75
⅜	6	5.25	4.5	4	3.25	3	2.5
½	5	4.5	4	3.5	2.75	2	1.75

Cast Steel Hoisting Ropes

6 Strands of 19 Wires Each—Hemp Center

1½	14	12	10	8.5	7	6	4.5
1⅝	12	10	8	7	6	5.25	4.25
1¾	10	8.5	7.5	6.75	5.5	5	4
1⅞	9	7.5	6.5	5.5	5	4.5	3.75
1	8	7	6	5.5	4.5	4	3.50
⅛	7.5	6.75	5.75	5	4.25	3.5	3
¼	5.5	4.5	4	3.75	3.25	3	2.25
⅜	4.5	4	3.75	3.25	3	2.5	2
½	4	3	3	2.75	2.25	2	1.5
⅝	3	...	...	2	...	1.5	...

Iron Hoisting Ropes

6 Strands of 19 Wires Each—Hemp Center

1½	12	11	9	7.5	6	5	4
1⅝	10	9	7.5	7	5.25	4.75	3.50
1¾	9	7.75	6.5	5.75	4.5	4	3.25
1⅞	8	6.75	5.5	5	4.25	3.5	3
1	6.75	6	5	4.75	4	3.25	2.75
⅛	6.75	6	5	4.5	4	3	2.50
¼	5	4.75	4	3.75	3	2.75	2
⅜	4.5	3.75	3.25	3	2.75	2.25	1.75
½	3.5	3.25	3	2.75	2	1.5	1.25
⅝	3	...	2	...	...	1.25	1

Waterbury Co.

KEY TO CONVERSION CHART FOR VOLUMES

SCALE A	SCALE B	SCALE C	To Locate Decimal* Below Center	To Locate Decimal* Above Center
Cu. Feet	Cu. Inches	N	+2	+3
Cu. Yards	Cu. Inches	E	+4	+5
Cu. Yards	Cu. Feet	I	+1	+2
Gallons	Cu. Inches	J	+2	+3
Cu. Feet	Gallons	B	0	+1
Cu. Yards	Gallons	M	+2	+3
Cu. Feet	Bushels	A	−1	0
Cu. Yards	Bushels	K	+1	+2
Cu. Feet	Liters	H	+1	+2
Cu. Yards	Liters	C	+2	+3
Bushels	Liters	G	+1	+2
Gallons	Liters	F	0	+1
Liters	Cu. Inches	D	+1	+2
Bushels	Cu. Inches	L	+3	+4

*The number of digits to the left of the decimal point in scale B is more or less than that in scale A by the amount shown in these two columns. The scales are read similarly to those on a slide rule, i.e., the numbered divisions represent the first significant figure, the intermediate unnumbered divisions represent the second figure, and the third figure must be interpolated.

Examples: (A) The number of Cubic Feet in 7 Cubic Yards is 189. (B) The number of Cubic Yards in 36 Cubic Feet is 1.33.

a point where the output of the boiler is restricted. Where natural draft and heavy suction obtains, greatest care must be exercised to prevent air infiltration through doors and other openings in the boiler and also air leakage through the walls of the boiler setting.

Passing all needed air through the fire insures that it meets the combustible at a high temperature; using minimum draft above the fire results in slow passage of gases over the heating surfaces, giving a maximum of time for absorption of heat. Thus the two conditions for effective operation of the heating surfaces are secured, tending to high efficiency and large capacity.

News Notes

WARREN WEBSTER & Co. announces the opening of its Texas office, 205 Sumpter Building, Dallas, Texas, with W. B. Irwin in charge as district representative.

ELEVATOR MANUFACTURERS of the United States held their semi-annual convention at the William Penn Hotel, Pittsburgh, Dec. 4, 5 and 6. Among the subjects discussed were cost systems, co-operative service, elevator regulations, service stations, and the prospects of the industry. Among the features of the occasion were a banquet, a theater party, and a trip to the works of the Westinghouse Electric & Manufacturing Co.

The following officers were selected for the coming year: President, I. N. Haughton, Haughton Elevator Co., Toledo; Vice President, O. P. Cummings, A. B. See Electric Elevator Co., New York; Secretary, Frank A. Hecht, Jr., Kerstner & Hecht Co., Chicago; Treasurer, J. H. DeVere, Ohio Elevator Co., Columbus.

VOLUNTARY ENLISTMENTS are again being accepted for the navy. Men between the ages of 18 and 35 with some machine shop experience may enter the service and have a complete course at the Machinist School, Charleston, S. C. Men from 18 to 30 with a theoretical knowledge of electricity and some practical experience are given a course at the Electrical School, Hampton Roads, Va. Apprentice seamen are also being accepted, firemen and machinists mates. The address when writing or for a personal call is Navy Recruiting Station, Transportation Bldg., Chicago, Ill.

CHAS. C. ENDERLE, who has been in the engine sales department of the Ball Engine Co. for some years, is now in charge of the Philadelphia district, with offices at 621 Commercial Trust Building, Philadelphia, Pa.

BURT O. GAGE, widely known as an inventor and pump expert, died at his home in Warren, Mass., Jan. 9, after a few days' illness of bronchial pneumonia. He was in his seventy-sixth year.

Mr. Gage had been associated nearly all his life with the pump industry, entering the employ of the Knowles & Sibley Co., manufacturers of steam pumps, in 1867. For about 40 yr. he was associated with this concern and their successors, The George F. Blake Mfg. Co. of Warren and Boston, during which time he patented many useful and practical ideas in pumping machinery. In 1905 he became associated with the Warren Steam Pump Co., Warren, Mass., as a superintendent, which position he held at the time of his death.

He had traveled extensively throughout the country, having charge of many water works installations. His ability to find the cause and overcome the troubles developed in pumping installations was recognized by all with whom he came in contact in the industry, and he was often referred to as the "greatest of all pump doctors."

At the time that the cruiser "New York," now the "Rochester," was being planned, Mr. Gage helped to develop successfully a vertical type of pump occupying small floor area and known today in the pump trade as the vertical twin air pump, which is still in successful use on naval vessels.

After becoming connected with the Warren Steam Pump Co., Mr. Gage invented a valve gear for direct-acting single pumps, in which the slide valve was moved from a state of rest, through mechanical action, and in which the valve-driving piston had only to continue and accelerate the travel already started. This valve gear proved successful under conditions of high steam pressure and superheat and when run without lubrication. He was also the originator and patentee in the use of monel sheets as pump liners.

In addition to his achievements in the design and operation of pump installations he originated many ideas in the line of tools and fixtures which brought about a higher efficiency in the manufacturing of pumps.

CHARLES R. EMERSON has been appointed General Sales Manager of the Foster Engineering Co. of Newark, N. J. Mr. Emerson was manager of the Boston branch for two years, and was manager of the Philadelphia office for six years from which position he was promoted to General Sales Manager.

KHU YOK CHIONG, P. O. Box 37, Iloilo, P. I., writes to Power Plant Engineering asking for catalogs of steam specialties, supplies and machinery for use in ordering material for overhauling and rebuilding a plant.

OSBORN MONNETT, formerly chief of the smoke inspection department of Chicago, and recently in Washington on the engineering staff of the U. S. Fuel Administration, has opened an office as consulting engineer at 1785 Old Colony Bldg., Chicago.

He will specialize on problems of power plant construction and operation from the coal pile to the switchboard, and has formed an alliance with the Commercial Testing and Engineering Co., which has thoroughly equipped laboratories for investigating the properties of coal and ash, so that the combined service will handle all questions, chemical and mechanical, that may arise in power plant practice.

Book Reviews

STORING, by H. B. Twyford; 196 pp, 96 illustrations, 6 by 9 in.; cloth; N. Y. 1918.

Storing raw materials and supplies is a problem of ever increasing importance, as a business grows, and as value of stock increases. The author points out that the storekeeper is in reality a trustee of wealth, and should be in position to guard, protect and conserve his stores, avoiding both oversupply and lack of materials.

In the book he shows that stores may become a source of profit or loss, depending on the market fluc-

tuations, that scientific storing is safe and sane and if properly studied may be the source of great savings and of improvement in the specifications for buying.

Advantages of various methods of storing are discussed, and the adaptation of each to different materials. Also the conveniences for moving to and from storage, means of keeping track of stores and of keeping inventories are treated in detail. Illustrations of apparatus and of blank forms needed are numerous and give much helpful suggestion.

GASOLINE AND KEROSENE CARBURETORS, by Victor W. Page; 320 pages, 89 illustrations; New York, 1919; price, $1.50.

Due to the ever-increasing demand for gasoline and its consequent continual rise in price, the matter of economy in its use has become a question of paramount importance. Such economy may best be realized by proper attention to the appliances employed in the feeding and introduction of this fuel to the engines utilizing it, and in order that those having to do with internal combustion engines intended to operate on liquid fuels, such as gasoline, kerosene, benzol and alcohol, may have a proper understanding of the construction, installation and adjustment of these devices this book on carburetors has been prepared. It should prove of particular interest and value to motorists, garagemen, students and repair men. All the basic principles pertaining to carburetion are explained, the leading types of carburetors are described in detail and carburetion troubles, fuel system troubles, carburetor repairs and installations, electric primers and economizers, hot spot manifolds and all modern carburetor developments are considered in a thorough manner. Methods of adjusting all types of carburetors are fully discussed, as well as suggestions for securing maximum feed economy and obtaining highest engine power.

INVENTORS' MANUAL—HOW TO WORK A PATENT TO MAKE IT PAY, by George M. Hopkins; 144 pages, illustrated; second edition, New York, 1918; price, $1.25.

This, the second edition of the book bearing the above title, is essentially a guide for inventors in perfecting their inventions, taking out their patents and disposing of them. In addition, considerable space is devoted to cautions as to pitfalls for the unwary, with particular attention to incompetent and bungling patent attorneys, and the tactics pursued by them.

For those who have perfected a device or design of any kind, and wishing to obtain a patent, the sections devoted to methods of application, the development of the invention and assignments should prove not only interesting but valuable.

Patent Tricks—Old and New is the title of the section exposing the means employed by unscrupulous persons either aiming to gain control of valuable patents or designing to fleece the inventor out of money, under the pretense of assisting him in the sale or marketing of this invention. From this the uninitiated should gain much information whereby he may be able to recognize meritorious propositions and thereby avoid unnecessary worry and financial losses.

Fifty-three pages of this edition have been devoted to tabulated census returns of 1910, indicating not only the population of the larger cities and counties of the various states, but also the number of individuals engaged in various occupations.

BULLETIN 106 of the Engineer Experiment Station of the University of Illinois gives the results of tests on a four-way reinforced concrete flat slab floor of the Western Newspaper Union Building in Chicago, Ill., just before it was razed in 1917 to secure space for the Union Passenger Station.

The floor construction used in the first five floors of the building was slab and girder type while that of the upper three floors was Turner mushroom flat slab type with four-way reinforcement. The tests were made on the sixth floor. A test load of 913 lb. per sq ft. was applied over four panels each 17 ft. 5½ in. by 19 ft. 4½ in. This load was considerably greater in proportion to the design load than had ever been used in previous tests of buildings. The information secured, therefore, which shows the action of the slab in its various parts given by the strain measurements has an important bearing on the design of the flat slab structure. The text of Bulletin 106 is adequately illustrated by means of photographs and diagrams in which such data as the following are given: "Arrangement of Reinforcement in Test Area," "Location of Gage Lines on Upper and Lower Side of Slab," "Load-deflection and Location of Deflection Points," "Load Strain for Gage Lines on Reinforcing Bars on Upper and Lower Sides of Slab."

Tests were conducted under the general supervision of Professor Arthur N. Talbot and the direct supervision of Harrison F. Gonnerman, Research Associate in Theoretical and Applied Mechanics in the Engineering Experiment Station.

Copies of Bulletin 106 may be had gratis by addressing the Engineering Experiment Station, University of Illinois, Urbana, Ill.

FUEL ECONOMY IN BOILER ROOMS, by A. R. Maujer and Charles H. Bromley; 308 pages, 92 illustrations and 18 tables; second edition, New York, 1918; price, $2.50.

In presenting the second edition of this book to the public the authors have done so under a different title, the original being "Fuel Economy and CO_2 Recorders." They also have extended the scope of the book so as to include fuels, firing methods, combustion of coal from the practical standpoint, fuel oil burning, stoker operation, boiler settings, burning low grade fuels and waste gases, ready means of checking boiler and furnace efficiency, etc., and in that way have materially increased its value.

But little of the matter contained in this book may be considered new, although its presentation is of such a nature as to make it quite appealing to the boiler room worker. The many clear illustrations embodied aid towards a more clear understanding of the text.

The book is divided into two parts. Part I is devoted to the subjects of combustion, coal analysis, flue gas analysis, heat lost in flue gases, draft and its measurement, chimney design, evaporation, boiler efficiency, heat balance, feed water treatment and CO_2 records. Part II treats of fuels, combustion in furnaces, boiler settings, firing soft coal, burning fuel oil under boilers, combustion losses in boiler operation, operation of mechanical stokers and economical boiler ratings.